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EDITORIAL ANNOUNCEMENTS

THE BRITISH AND EASTERN CONTINENTS edition of the Railroad Gazette is published each Friday at Queen Anne's Chambers, Westminster, London. It consists of most of the reading pages and all of the advertisement pages of the Railroad Gazette, together with additional British and foreign matter, and is issued under the name Transport and Railroad Gazette.

CONTRIBUTIONS.—Subscribers and others will materially assist in making our news accurate and complete if they will send early information of events which take place under their observation. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired.

ADVERTISEMENTS.—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay, EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and these only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers, can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially either for money or in consideration of advertising patronage.*

VOL. XXXVIII. No. 3. FRIDAY, JANUARY 20, 1905.

CONTENTS

EDITORIAL:

Measuring Locomotive Performance	46
It Is General Rate-Making	46
Report Michigan Railroad Commission	47
Editorial Notes	45, 46, 47
New Publications	48
Trade Catalogues	48

ILLUSTRATED:

Mikado (2-8-2) Loco.; Northern Pacific	50
Wooden Tie Plates on the Santa Fe	54
Tests of Reinforced Concrete Beams	55
The Friburg-Morat-Anet Electric Railroad	59
High Capacity Cars on the G. C. of Eng.	60
Railroad Shop Tools	62
Cole's Radial Locomotive Trailing Truck	64
Roaring Rails	66
New South Wales Suburban Tank Locomotives	68

CONTRIBUTIONS:

Block Signals in the Subway	48
Cole Four-Cylinder Balanced Compound	49
Union Stations at St. Louis and Buffalo	49

MISCELLANEOUS:

Application of Electricity to Steam Roads	49
Rails for Lines with Fast Trains	52
Carbonic Acid Gas for Signals	53
Teaming Yards	58
Census Bureau Report on Telephones and Telegraphs	63
Picked Up on the Road	65
Court Decisions on Traffic Questions	65
Telephones on the B. & O.	67
Autobiography of H. H. Vreeland	68

GENERAL NEWS SECTION:

The Scrap Heap	17
Meetings and Announcements	20
Personal	20
Elections and Appointments	20
Locomotive Building	21
Car Building	21
Bridge Building	22
Railroad Construction	22
Railroad Corporation News	24

It was announced last week that three electric interurban roads comprising a large part of the mileage of the so-called Appleyard system in southwestern Ohio had been forced into a receiver's hands because they could not meet their indebtedness. The general manager is quoted as saying that the rates of fare have been too low for profit and that the large floating debt of several new uncoupled lines absorbed by the syndicate could not be carried as an extra burden by the older and stronger roads which have been in operation some time. About three years ago the Everett-Moore syndicate, of Cleveland, passed through a similar experience, due to the same causes. We have pointed out before in these columns some of the dangers of the financial and operating policy which has dominated most of the electric interurban roads—the creation of a large bonded debt and the payment of dividends on the common and preferred stocks out of the apparently large net earnings which were swelled by the omission of any expenditures for permanent improvements or deductions for the sinking fund. Permanent improvements, if made at all, have usually been capitalized freely on the assumption that if the road showed large net earnings during the first few years of operation (chiefly because of the omissions noted), when the time came for renewals and for heavy betterment expenditures, the natural development of traffic would pay interest and dividends and leave enough for all other expenditures. This is a risky policy, savoring of the promoter, and it is bringing near at hand the period of foreclosure and reorganization which seems inevitable for much of the electric mileage in the country before these properties can be put on the final sound basis of conservatism, in connection with their great and undoubted public utility.

About a month ago (Dec. 23) we referred to the passing of its dividend by the Massachusetts Electric Companies, the great street railway "holding" corporation of that state, as evidence of the reaction in street railway building and prosperity. The returns of the Massachusetts Railroad Commission now amplify the evidence as to the whole state. They show that, for the last fiscal year, while gross assets of Massachusetts street railways increased $1,979,525; gross liabilities increased $2,928,075; surplus decreased $976,952; net earnings decreased $211,488; and dividends fell off $371,752. Of 74 operating companies 30 failed to earn expenses and fixed charges and only 14 corporations, out of 25 that paid dividends, actually earned them, while five companies became insolvent. To the 2,670 single track miles of street railway in 1903 only about 53 miles were added in 1904, in striking contrast, for example, with 282 miles added in 1902 or 264 miles added in 1901. These ominous results have been attended, too, with failure of many companies to provide for depreciation of plant and equipment. While something must be allowed for an exceptionally hard winter, on the other hand these reactions have taken place in a state with 34 cities and where local densities of population have been singularly promising for profit in street railways, and, moreover, where honest capitalization has been enforced by the most efficient state railroad commission in the country. If such results have come to pass already in Massachusetts, what is to be looked for in some other states where street railway building has been less restrained? And one may well look forward with anxiety to the time when the electric street railways meet their first wave of industrial depression. More and more does the fact grow conspicuous that the street railway, its somewhat deceptive "novelty" period and its epoch of profitable change from the old urban "horse" railway once passed, has become subject to the same law of investment, wise or rash, that has followed up the steam road, or, for that matter, every other business enterprise.

Our correspondent, R. A. D., who proposes to shorten the block sections on the express tracks in the New York City Subway from 1,600 ft. to 800 ft., suggests the abandonment of an important safeguard, for the sake of saving a little time. Whether or not the automatic stop will ever fail, and fail coincidently with a careless, incompetent or disabled motorman, and thus cause a collision, we cannot tell; but most people, howsoever anxious to get to their offices, would probably justify the road in refusing to give up the automatic appliance; they would wait for some other remedy. Some managers would perhaps be ready to do without the "stop," on a road like this, if they could have two lookout men on each train instead of one; but will R. A. D. assert that 100 or 500 extra men could by reasonable effort be disciplined to the degree where a passenger could feel as safe with two lookout men and no "trip," as with one man in the cab and a complete equipment of trips? The 50,000 locomotive firemen of the United States have not made an enviable reputation as auxiliary or assistant lookout men. It is true that the Subway signals keep trains 1,600 ft. apart; but is it fair to call this "delay"? The term is relative; or, rather, depends on the speed. At speeds of 10 miles an hour a 500 ft. block might be called a cause of delay; but if we are to have high speed we must have long distances in which to stop. If it were practicable to allow trains to be slackened by the automatic apparatus in every-day practice, we might then do away with the overlap, and put the "trip" opposite the distant signal, and thus reduce the minimum distance between trains; but in thus reducing the margin of safety from 100 per cent. to 10 per cent., or some such small figure, it is doubtful whether we should have the endorsement of conservative experts. R. A. D. seems to forget that the real causes of delay (which he mentions—slow unloading at Brooklyn Bridge) indicate a violation of an elementary principle in block signaling, namely, the principle that, for economical operation, the block sections must be of uniform length, as measured, not in linear feet or miles, but in time consumed by trains. The first remedy to be applied should be the removal of this fault. If a train at Brooklyn Bridge terminal delays trains following, it is because it remains too long in the terminal block. How long a time

do these trains require to unload? If more than 15 or 20 seconds, the use of cars with numerous side doors would, obviously, increase the capacity of the line. If, with stops shortened to 20 seconds, the trains continued to delay those following, that would indicate that the terminal block section was still too long; and if it could not be made shorter without shortening the trains, the remedy indicated would be the widening of the station, so as to have an additional unloading track and platform, as in the bridge-railroad terminal a few rods distant.

It would be possible, of course, to introduce a compromise at the Brooklyn Bridge terminal. On the theory that an additional lookout man would answer in place of the automatic stop, one extra lookout man would answer for all the trains by stationing him on the ground and giving him power to withdraw the trip for all trains not running too fast. It would be possible also to put in a sand track, to shorten the distance necessary to allow room for preventing collisions. In fact, the signal engineer can do anything within reason, even to the extent of providing a diverging track (in lieu of a derailing switch) at each signal. By using such tracks, with accompanying home and distant signals, he can provide for the safe running of trains at high speed 500 ft. apart. It is no fault of his that the Subway cannot afford to dig side tunnels for diverging tracks. But neither the signals nor the signal maker can be held responsible for slow movements, either of cars or of passengers who cannot or will not "step lively." Our correspondent's assertion that the local trains (on tracks not block signaled) make better time than the express trains cannot be considered seriously until he shows whether or not the frequency of the trains and the number of passengers carried are on a parity with those features of the express traffic. Numerous observations at express stations indicate that the local trains are able to make shorter stops because they have fewer persons to load and unload. Comparison with the elevated lines is also faulty because the safety of the elevated is in large measure due to the moderate speed of the trains.

MEASURING LOCOMOTIVE PERFORMANCE.

The derivation of some unit or basis by which to make equitable comparisons of locomotives as traffic movers has been a subject for thought and study on the part of railroad officers and statisticians. The desire for some such comparative measure has grown with the efforts to lessen the cost of handling traffic, and with the growth in size and variety of types of locomotives. It has not only been considered possible that a means might be derived by which just comparisons could be made of results between different locomotives, or classes of locomotives, on different divisions, or districts, of a system, but that a unit of universal applicability might be found, which would enable comparisons to be made between different roads.

Units or expressions of one sort or another have been proposed and used. Mr. Worthington, of the Southern Pacific, some years ago employed a unit which he expressed as gross ton miles per thousand pounds of engine traction, the engine traction in every case being taken as one-fifth the weight on drivers, and he used it for a time to compare and judge the performance of locomotives on different divisions. But one division being a valley division with easy grades, and another a mountain division with heavy grades, it soon became plain that an injustice was being done the locomotives on the heavy division. Locomotives on the mountain division could haul something like 18 or 20 tons per unit of engine traction, while those on the valley division could easily take 50 to 75 tons over the road. The use of the unit was therefore abandoned.

A unit quite similar has recently been adopted by the statistical department of the Santa Fe as a measure of, and a unit for comparing, the performance of locomotives on different parts of that system. But instead of expressing the performance in terms of gross ton-miles per unit of engine traction, gross ton-miles per traction ton-mile are used. The traction ton-miles are the product of the mileage of the locomotive and its weight on drivers in tons. The reason given for taking weight on drivers in preference to tractive power, a theoretical quantity, is because of the lack of agreement among the authorities regarding the exact formula for the latter; while the weight on drivers is a constant and is an absolute measure of the hauling capacity of the locomotive. This, of course, assumes that every locomotive in the comparison has cylinder power sufficient to slip its drivers under all conditions. The assumption is not a safe one, however, as there are probably few, if any, roads that do not number under-cylindered engines among their motive power. But while the traction ton-mile may be a better unit in some respects than the Southern Pacific unit, it is open to the same fundamental objection, namely, that it leaves out of consideration entirely some of the most vital factors affecting locomotive performance.

The more carefully this question is studied the more apparent it becomes that no basis for comparison, of the kind described in the foregoing, is possible, except as between different periods for the same division of a road; and even here similar periods must be chosen in order that the variable conditions may fairly be assumed to average up the same, otherwise the results may be misleading and the comparisons unfair. But between divisions the only comparison possible is one of efficiency; of what each locomotive, or class of locomotives, is doing compared to what it should do. This comparison must, of course, be based on some carefully worked-out and comprehensive engine rating system, such as that of the Southern Pacific, and the efficiency expressed as the ratio of actual gross ton miles to theoretical gross ton miles. When a locomotive on a level division is doing 90 per cent. of its correct theoretical rating and its sister on a hilly division shows a similar efficiency, the two are doing equally good work, although the gross ton miles per unit of engine traction, or per traction ton mile, for the two will exhibit a considerable discrepancy. As to comparisons between different roads, they will be possible only when a universal tonnage rating system prevails.

IT IS GENERAL RATE-MAKING.

Objection is raised in some quarters to the use of the term rate-making in connection with the enlargement of powers which is sought on behalf of the Interstate Commerce Commission. There is in this term a suggestion of arbitrary interference with contractual relations which in most cases are perfectly harmonious that is not without a substantial basis. The liberty-loving people of America are not yet ready generally to substitute arbitrary statutes for free contracts and those who would move in the direction of such a substitution are undeniably acting the part of wisdom when they seek a less repellant designation of the measure they advocate. To ask for power "to correct a rate," or "to substitute a reasonable rate for one which has been found to be unreasonable," particularly when it is provided that the power is never to be exercised except after "complaint, full hearing, a report and opinion," and proceedings "essentially judicial in character and form" sounds like a comparatively harmless invasion of the liberty of individuals to contract freely for the services which they require. It is seldom profitable to spend time in discussion over definitions and in the present instance the facts are so far beyond dispute that were the influence of words and names upon public opinion less profound there would be a little controversy over the terms by which the facts are characterized. But the human mind still works much as it did in the time of Bacon, and there is yet far-reaching truth in his observation that:

> The idols of the market place are the most troublesome of all—those namely, which have entwined themselves round the understanding from the association of words and names. For men imagine that their reason governs words, whilst, in fact, words react upon the understanding; and this has rendered philosophy and the sciences sophistical and inactive.

The Interstate Commerce Commission has chosen to designate the power it seeks as that to "order the reasonable rate to be substituted for that which has been found to be unlawful"; the President calls it "the power to revise rates and regulations"; the opponents of the proposed modifications in the law call it "general rate-making." Now if the Commission had used plural forms and said "order reasonable rates to be substituted for those," etc., it would have been accurate to declare that none of these characterizations is wholly inapplicable. The proposed changes in the law would provide for general rate-making through empowering the Commission, after observing certain formalities of procedure, to "revise rates and regulations" and to substitute what it should regard as a reasonable rate for each and every rate complained against and thereafter decided to be unlawful. The basis of the proposed exercise of enlarged authority is to be a complaint and the jurisdiction of the Commission, in each case within the general scope of the law, is to be as broad or as narrow as the complaint. What are the limits of the complaints, thus becomes a vital inquiry. First, it is to be observed that any one may complain. The law declares that "no complaint shall at any time be dismissed because of the absence of direct damage to the complainant," and in Interstate Commerce Commission vs. Baird (194 U. S., 25) the Supreme Court decided that after the filing of a complaint "no alternative is left the

Commission but to investigate the complaint if it presents matter within the purview of the Act and the powers granted to the Commission." The law also provides that "any person, firm, corporation, or association, or any mercantile, agricultural or manufacturing society, or any body politic or municipal organization," may be a complainant. Again, any complainant may attack in his complaint all the rates between any two points or from and to any number of points, the only limitation being that they shall be rates applicable to traffic crossing state or territorial lines in passing from one state or territory to another or to or from a state or territory from or to a foreign country. In fact, a single complaint might involve every railroad rate applicable to interstate or foreign traffic originating at or destined to any and every point in the United States. This statement may be startling to those who are but superficially acquainted with the work of the Interstate Commerce Commission, but it will not be surprising to any one who has followed its decisions or studied the law or its interpretation by the Federal Courts. An excellent illustration is found in the very case in which the attempt of the Commission to prescribe future rates was declared to have exceeded its authority. This case, being originally that of the Freight Bureau of the Cincinnati Chamber of Commerce vs. the Cincinnati, New Orleans & Texas Pacific Railway et al., was heard and disposed of by the Commission together with that of the Chicago Freight Bureau vs. the Louisville, New Albany & Chicago Railway et al. (4 Inter. Com. Rep., 593). The breadth of the complaint and the scope of the Commission's decision and order, in this case may be gathered from the following extracts from the opinion of the Commission:

> The general ground of complaint in the Cincinnati case is that the rates of freight established by the defendant carriers from the Eastern Seaboard and Central territories, respectively, to Southern territory (the Commission defined Eastern Seaboard territory as consisting of Baltimore, Philadelphia, New York and contiguous territory; Southern territory as consisting of Knoxville, Chattanooga, Rome, Georgia, Atlanta, Birmingham, Anniston, Selma, Alabama; Meridian, Mississippi; and contiguous territory; Central territory as consisting of Cincinnati, Louisville, Indianapolis, Evansville, Chicago, Cairo, St. Louis and contiguous territory) unjustly discriminate in favor of the merchants and manufacturers whose business is located and transacted in Eastern Seaboard territory and against merchants and manufacturers whose business is located and transacted in Cincinnati and other points in Central territory. It is stated that "the burden of the complaint lies against the relation which exists between the current rates of freight on manufactured articles and merchandise. . . . The complaint in the Chicago case contains similar tabular statements and charges, made applicable to Chicago, and in addition calls in question the reasonableness in themselves of the through rates from Chicago to Southern territory. . . .

The foregoing shows that the mere filing of this complaint, followed by an investigation conducted "in such manner and by such means" as the Commission should "deem proper," under a statute similar to the pending "Quarles-Cooper" bill, would have given the Commission authority to change the rates or the relations among the rates, which is the same thing, on all southbound, through railroad freight in all of the United States east of the Mississippi river. This is general rate-making. The Commission's order in this case (which the Supreme Court refused to enforce) specifically required changes in the rates from Cincinnati and Chicago to Knoxville, Chattanooga, Rome, Atlanta, Meridian, Birmingham, Anniston and Selma, and also directed the carriers to readjust their rates from the same points of origin "to points other than those herein above specified," so as to establish due and proper relations to the rates specifically applied to the points named. The Commission added:

> We are not unmindful that a compliance with the order in these cases may and probably will necessitate a readjustment of rates from Central territory to other points in Southern territory than those named. . . .

Among many other illustrations of the magnitude of the authority which is proposed to base upon the complaint of persons who need make no show of direct damage in order to have standing before the Commission the complaint of the Business Men's League of St. Louis against the Atchison, Topeka & Santa Fe Railway et al. (9 Inter Com. Rep., 318) is typical. Every important railroad system west of the Mississippi river was a defendant in this case. The Pacific Coast Jobbers' and Manufacturers' Association intervened on behalf of the defendants, while, as intervenors on behalf of the complainant there appeared several of the greatest jobbing firms of Chicago and commercial organizations representing the cities of Milwaukee, Kansas City, St. Joseph, Duluth and Santa Ana, Cal. Among other matters involved in the complaint was the classification of freight applied to all traffic not carried on special commodity rates in the whole territory from the Great Lakes and the Mississippi river to the Pacific Coast. Most of the important commodity rates in the same territory were also involved. The Commission preferred to issue no order in this case and to hold it open for further investigation, but its report and opinion states conclusions from which it is evident that if its authority were sufficient, as it would have been under the "Quarles-Cooper" bill, the Commission would undertake a general revision of all the railroad freight rates in this vast territory. These are the facts. Advocates of legislation which would hamper every other industry along with that of the railroads may try to belittle the proposed changes in order to smooth the road to their enactment, but those who will take the trouble to examine a few of the cases already decided by the Commission will not easily be deluded. The power "to revise rates and regulations" is the power generally to make rates. Applied to American interstate and foreign railroad services it is greater power than has ever been exercised by any president or prince, by any Congress or Parliament, by any body of five men or of five thousand men. It is power to bind or to loose industry, to enrich or to impoverish both labor and capital, to build up or to tear down communities and commerce. Given to the Interstate Commerce Commission it will not have been transferred from the railroads, for, neither singly nor collectively, can they or do they now exercise it; it will have been taken from the public, travelers, shippers, and railroads; among whom it is now diffused, and concentrated in the hands of a Government which by that act of concentration will be made the most powerful and the most centralized of any government on earth from the earliest dawn of history to the present day.

Report of the Michigan Railroad Commission.

An abstract of the annual report of the railroad commissioner of the State of Michigan has just appeared, dated December 31. While the aggregate gross earnings of the railroads, amounting to approximately $45,000,000, are about 2.8 per cent. smaller than last year, they are considerably larger than for any previous year except 1903. This single figure is the only strictly statistical information which the report contains, although a general review is made of the physical condition of the railroads of the state as compared with last year. The report says that decided improvements have been made during the year upon the permanent way; that the number of pile and timber trestles have been reduced; that the majority of the roads have done considerable ballasting, and that the surface and alinement of track is generally good. This feature of the report does not possess any great value, as it simply amounts to a statement in rather general terms that improvement is being made in each of the physical features of the road where improvement was to have been desired.

The greater part of the abstract at hand is concerned with a recommendation for new legislation. The board finds that the railroads are disposed to evade the law requiring that new railroads, or railroads extending their lines, shall submit a map of their route to the commission and await their decision as to the type of crossing which shall be provided where the new line crosses existing lines, whether at grade or otherwise; and it recommends that the law be made more strict. It finds that the law is also deficient with regard to crossings of steam railroads by electric roads, and *vice versa*. At the last session of the legislature a law was enacted providing for the exercise of the police power of the state over electric railway corporations and purporting to bring this class of companies under the jurisdiction of the commissioner of railroads to about the same extent that general railroad companies are controlled. The commission, however, finds that this law is incomplete and unsatisfactory for the reason that it does not clearly specify the manner and extent to which the authority of the commissioner is intended to be exercised, and it desires that this law shall be clarified and stiffened. Attention is also called by the board to the rather humorous incongruity of the existing laws which require railroads to make their annual reports for the calendar year ending December 31, and the commissioner of railroads to make his report for the same period, with the result that he cannot obtain in time for publication any statistics which are less than a year old. It is urged that the companies be compelled to report for the fiscal year ending June 30. Among other suggestions for new legislation is a strong appeal for a Federal act requiring block signaling as an adjunct to the safe operation of trains and a suggestion that the state enact that no freight classification be changed without further authority than that of the railroad officials or organizations and not until after a full hearing at which all interested persons should be given an opportunity to be heard. The commission says, however, that few complaints have been received from shippers either as regards the rate or as regards claims of discrimination between shippers.

Mr. L. S. Cass, President of the Waterloo, Cedar Falls & Northern, a steam road in Iowa which was equipped some time ago for partial operation by electricity, read a paper

before the Iowa Railway Club last month on the Application of Electricity to Steam Roads. Extracts from this paper are printed elsewhere in this issue. Mr. Cass sums up the positive advantages of electric operation over steam operation in four words—no smoke, no smell. He claims that to equip a steam road for electricity would cost quite as much for new cars and power house machinery as the steam equipment would cost and in addition there is a minimum extra cost of $3,000 a mile for transmission line and substations. The efficiency of an electric system is no greater than the efficiency of an individual locomotive for long heavy trains, according to his statement, and he quotes Mr. Harahan, Second Vice-President of the Illinois Central, in support of it. Mr. Harahan is said to have demonstrated, some three years ago, that the Illinois Central could not afford to electrify its Chicago suburban service and that the present method of operation with small locomotives was more efficient than any electric scheme proposed. Mr. Cass is one of the few men in this country who can speak from experience of the comparative economies of steam and of electric working, and his views on the advantage of electrification are not highly optimistic. No important roads in this country have as yet been electrified although within the next five years the suburban lines of the New York Central and the Long Island will have been changed over. Saving in operating cost was hardly as important a consideration with the New York Central as was the avoidance of smoke in the tunnel, and acceleration of the service. On the Long Island the contemplated advantages will probably be realized because the consideration with the New York Central as Pennsylvania's power house, which will supply current for the Manhattan terminal, will also supply power for the suburban trains and an extremely heavy traffic is expected to be developed. As pointed out in the paper, heavy and dense traffic are vital elements in the success of any electrification scheme.

NEW PUBLICATIONS.

Roofs and Bridges. Part I. Stresses in Simple Trusses. By Mansfield Merriman and Henry S. Jacoby. Sixth edition, rewritten and enlarged. New York: John Wiley & Sons, 1905. Cloth, 326 pages. Price $2.50.

This book by Professors Merriman and Jacoby, which was first published in 1888, needs no introduction to engineers or students. It has long been a standard reference and text book not alone because of its complete treatment of the entire subject indicated by its title but because of its simple and direct methods of analysis of the stresses induced in framed structures. The complete work includes four volumes of which this is the first; the others cover Graphic Statiss, Bridge Design and Higher Structures. So many changes have come about in bridge design in the last decade, new conditions of loading have had to be met, mill practice in the fabrication of structural material has advanced rapidly, and many of the older types of trusses have almost entirely disappeared. For these reasons the edition of Part I. now issued has been completely rewritten and greatly enlarged. The number of chapters has been increased from six to eight, the number of pages from 191 to 326, and the number of illustrations almost doubled. Chapter 6, which is entirely new, treats of portal and sway bracing, bridge members and floors and plate girder bridges. Throughout the book the former classification for bridges has been abandoned and the subject matter has been arranged in chapters dealing with the different loads involved, dead load, live load, wind and snow loads and total loads. An interesting and valuable chapter is the one on American bridge trusses which is largely historical and contains examples of practically every type of early and modern truss bridge used in America. Numerous photographs of typical bridges have been reproduced in the text and a table of long span truss bridges has also been included.

TRADE CATALOGUES.

Pneumatic Tools.—The Rand Drill Company, New York, sends its first number of "Air Power." This is to be published quarterly by the above company and its contents will be devoted to the varied uses of compressed air. The current issue contains some interesting illustrations which show pneumatic tools in use in the subway, on the new Trinity building, New York, and in excavating in the New York Central yards. It also contains an extract of a paper by J. B. Carper on "Trials of Rock Drills." A table accompanies this article which gives the relative air consumption per cubic inch of rock drilled by the different makes of drills.

Coal Mining Machinery.—The Ingersoll-Sergeant Drill Company, New York, sends its catalogue No. 52. It is devoted entirely to coal mining machinery and includes a comprehensive article on the use of pneumatic tools for this purpose. Appropriate illustrations showing the different tools in actual use are also given. Illustrations of the Ingersoll-Sergeant air compressors are shown, and the matter of pneumatic haulage is also treated at length.

Tempering Compound.—C. A. Mosso, Dryden, N. Y., maker of "Monarch" tempering compound, sends a small 12-page pamphlet, one-half of the contents of which form an interesting talk on tempered tools and the advantages of "Monarch" tempering compound. The remaining pages contain facsimile testimonial letters, highly favorable in tone, from prominent users of the compound.

Oil Switches and Oil Circuit Breakers.—The Westinghouse Electric & Manufacturing Co., Pittsburg, Pa., sends its circular No. 1,096, in which detailed descriptions and illustrations are given of oil switches and oil circuit breakers.

CONTRIBUTIONS

Block Signals in the Subway.

New York, Dec. 15, 1904.

To the Editor of the Railroad Gazette:

The patrons of the Subway in this city have been patiently enduring exasperating delays in their morning and evening journeys up and down town since the opening of the line, more than a month ago, in the hope that more experience on the part of the employees and continued careful supervision by the officers would put the complex machinery of the underground railroad in smooth working order. But instead of any improvement in the train service, the delays seem to be longer and more frequent every day. If in the last three weeks a single express train between 8 and 9:30 in the morning has made the run from 96th street to Brooklyn Bridge within ten minutes of its scheduled time, the writer would be glad to know of it. It seems to be impossible for the express trains in particular to be run on anything near the headway for which the entire establishment was supposedly designed. Something is at fault and the question is, what?

A careful consideration of the traffic conditions leaves only one conclusion and that is that the system of signals installed, delays, rather than expedites, the movement of trains. Part of the delay, of course, occurs at stations in loading and unloading passengers; but during the rush hours the local trains are crowded, too, and despite the fact that they make six station stops to one made by the expresses they often make better time, under present conditions, than do the expresses. Any improvement in the facilities for getting passengers in and out of cars would be almost as noticeable in the one case as in the other. There is also the inexperience, or rather lack of skill, of the motormen in starting and stopping trains. The average time of making a stop is much longer than on the elevated lines, chiefly because the motormen seem to be over-cautious in applying the brakes. But these minor delays do not account for the constant congestion or for the experience of passengers who frequently find that the expresses take more time for the run below 42d street than the locals do, in rush hours. The only visible explanation is that the express tracks are block signaled and the local tracks are not.

The block signals in the Subway are an experiment and apparently an unsuccessful one. It is the first time that signals have been put in with such short blocks and long overlaps, with absolute blocking made compulsory by the use of the automatic stops. The fundamental theory of a space interval between trains, on which any system of block signals is based is, no doubt, correct in principle, and the writer is not disposed to dispute the assertion that the installation of block signals expedites the safe movement of trains, *up to a certain point.* In the Subway the economical limitations of the system have been exceeded; speed of trains and therefore the capacity of the line has been sacrificed for safety. But cannot reasonable safety of operation be accomplished without cutting down the number of trains or greatly reducing their running time over the hypothetical schedule as now in force. Hypothetical, because it does not and never has existed in reality.

The considerations involved in the design of the signal system in the Subway are to the best of the writer's knowledge as follows: Maximum speed of trains, 45 miles an hour; minimum distance between signals, 820 ft., or slightly greater than the stopping distance of a train at maximum speed; length of overlap, the distance between signals. Theoretically this gives a maximum capacity equal to a train every two minutes. On the local tracks the only signals are at the entrances to stations and caution indications at curves. Between stations the maximum speed of the local trains is not very much less than the speed of the expresses, and yet it was not considered necessary to put in mechanically absolute blocking on these tracks. Why then is it so essential on the express tracks, where the trains are supposed to run at less frequent intervals? If the infallibility of the motorman of a local train is thus relied upon, why cannot the motorman of the express trains be relied upon in the same manner?

With absolute blocking in operation there is a delay at every stop which the train makes, and it is almost impossible to clear a blockade within reasonable time. For example: At Worth street there is a home signal on the southbound express track which is about 1,000 ft. from the end of the Brooklyn Bridge station, the southern terminal for

express trains. This signal does not clear until the train ahead, standing in the station, has pulled out and left the track clear in front of the platform. A train approaching Worth street from the north is brought under control at the first signal north of this home signal and is stopped before reaching it. This train must then stand 600 or 700 ft. away from the station until the preceding train has discharged its passengers and pulled out. From the time the signal at Worth street clears to the time the train stops at the platform is between 30 and 40 seconds, which is time wasted. If the train was allowed to approach the station under control and then followed the preceding train within a few feet, at least 20 seconds would be saved at this one point alone. Twenty seconds delay to each train means much longer delays to following trains in the course of an hour or two during the morning rush.

There was no necessity in the first place for the extremely complicated and expensive signal installation which has been put in, but inasmuch as it is in operation and paid for it might be rearranged and made to assist in running trains instead of retarding them. The first thing which ought to be done is to take out the automatic stops and make the system one of permissive blocking instead of having absolute blocking with an overlap. This would provide for every contingency of fog and obstructions on curves, by giving an indication of the position of the train ahead and at the same time would allow the running of trains under control at intervals of only a few yards, as is now done on the local tracks in the Subway and on the elevated roads, whenever a delay or blockade occurs. The average running time with such a system would be no less than at present during slack hours and would be much shorter than at present with the congestion during rush hours. The basic principle of the block system would, of course, no longer exist, that is, the fixed space interval between trains would be abandoned; but the average business man in a hurry to get to his office would condone the renunciation of an ideal principle if he could count on getting there somewhere near on time. The elevated roads for a quarter century have trusted to the vigilance and judgment of the men running trains, and their boast is that they have never killed a passenger riding in their cars. The general public rides on the elevated trains without hesitation; yet the elevated lines are not equipped with block signals that block traffic.

R. A. D.

The Cole Four-Cylinder Balanced Compound.

Urbana, Ill., Jan. 10, 1905.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In reading Mr. Cole's answer to my criticism of New York Central engine 3,000 (see *Railroad Gazette*, Dec. 2 and Dec. 16) I was struck by the fact that he devoted considerable space to proving something which I admitted in my criticism, viz., that so far as a horizontal plane through both axles was concerned, the engine was balanced. But the vertical balancing was what I called into question, and I think no one will deny that vertical forces are caused by the horizontal reciprocating parts through the angularity of the main-rods. These forces may be smaller than at first appears in comparison to the other forces acting on the wheels, but they exist, and vary during every revolution. The severity of the hammer-blow caused by them depends upon the rapidity of this variation; that is, upon the speed of the engine.

There is a further point which I did not bring up in my first communication, and that is the variation from a true balance caused by the inside main rods being shorter than the outside main rods, though this variation is not large in all probability (see *Railroad Gazette* May 13, 1904). Further, in any four-cylinder locomotive with the cranks mutually at right angles, there is a couple acting in a horizontal plane which cannot be balanced without the use of counterweights in the wheels. This, of course, at once unbalances the engine vertically and causes the same hammer-blow trouble, due to the counterweight, which is met with in the ordinary simple two-cylinder locomotive. In an engine as long as the Cole engine, its moment of inertia is doubtless large enough to make the effect of this couple not serious, even if left unbalanced.

As to Mr. Holbrook's criticism (Dec. 16) that the cylinders are not in the same horizontal plane, I think he is mistaken and probably has confused the piston-valve chests with the inside cylinders.

L. E. MOORE.

Union Stations at St. Louis and Buffalo.

St. Louis, Jan. 14, 1905.

TO THE EDITOR OF THE RAILROAD GAZETTE:

I note, in your issue of Jan. 6, 1905, an article entitled, "Proposed Union Station for Buffalo." In the statement published in that article I also note that you put our Union Station facilities considerably in the background, as shown by errors in said statement. This statement, so far as it effects Union Station, St. Louis, should be corrected as follows:

No. of railroads	25
Movements daily passing tower	2,500
No. of stub platform tracks	32
No. of through platform tracks	0
Total No. of tracks	32
Capacity, Locomotives	61
Capacity, cars	1,000
Length of terminal, miles	1.9
Length of Depot Parcel, feet	1,885
Width of Depot Parcel, feet	606 to 1,865
Acreage total for Passenger Terminals	73
Acreage Depot Parcel	55
Capacity through platforms in cars	0
Capacity stub platforms in cars	11
Miles of Track, Depot Parcel	24.7
Miles of track, total	39.3

J. L. ARMSTRONG, ENG. MAINTENANCE-OF-WAY.

The Application of Electricity to Steam Roads.*

The first essential requisite to the successful operation of a railroad by electricity is a contiguous population requiring cheap, frequent and rapid transportation in the conduct and interchange of their daily vocations. This condition then calls for the operation of numerous small units and concentration of energy. The Waterloo, Cedar Falls & Northern operates within and between the cities of Waterloo and Cedar Falls numerous small units, and the power house installation does not exceed 40 per cent. of the rated horse-power of the electric cars, for the reason that the cars are not all using their maximum power at the same time. Occasionally the power demands are greater than the generator can supply, in which case the automatic circuit breaker opens the circuit and all cars come to a standstill in the section affected. When again the circuit is closed the cars do not act simultaneously in getting started and the power supplied is sufficient. With a city line as a foundation it is possible to radiate from a market town with short country lines at a profit.

Electricity can be used consistently for motive power on country lines when the source of supply is consolidated with an electric light plant or water power company. Some small industrial roads are using electric power from their manufacturing plants, but in each such case there must be a foundation to support the added cost of installation, for an electric railroad costs all that a steam line costs to perform the same service and in addition the electrical installation in no case costs less than $3,000 per mile. The length of line which can consistently be electrically equipped depends wholly upon the nature of its traffic and the density of population. The reports of some of the eastern electric railroads show large earning power and continued extension of lines. Iowa will never be able to sustain numerous small electric railroads until the population in both cities and rural districts has greatly increased, and then not while the chief pursuit of the people is tilling the soil. Through the eastern states the cities are large and numerous and are made up of residents who are wage earners in the large factories. They draw their pay on Saturday nights and ride on the trolley to get into the country on Sunday, and to and from their labors on week days. The rural population is made up, to a great extent, of miners, gas and oil well drillers and numerous other wage earning pursuits which bring them their salary on Saturday night, and they in turn ride on the trolley to get to the city. This is not true of Iowa cities. They are made up of a number of people termed business men who have formed settlements or trading posts throughout the state for the benefit of the Iowa farmer, who gets his income once a year when he markets his crop. He has a stableful of horses to haul himself and family to the trading post once or twice each week; therefore, the greater part of Iowa is destined to be without the rural or farmers' railroad for some time to come.

We operate an electric switch engine in Waterloo and Cedar Falls for industry switching to small and isolated plants that require service occasionally, and for this work the electric engine is ideal, as it can pass around very short curves. Industries are not afraid of fire from it, nor does it annoy people with smoke and steam. It is always ready, and when through work the coal consumption stops when the machine stops. For yard work the electric locomotive is not feasible, neither is it suitable for drawing heavy freight and passenger trains, as the heavy trains would overload the power house and no other cars could operate while they were being moved. One freight train would probably require the maximum output of the power house and we would be burning coal and conveying the power over a conductor for miles, at a great loss in transmission, when we can burn the coal in a locomotive right at the point of service, just as cheaply, considering the loss in conductivity.

The amount of coal burned on our locomotives for the past eight months has been 1.4 tons per 10,000 ton miles, while for electric service nine tons per 10,000 ton miles have been used. This is not a fair comparison for the reason that the coal used in the locomotives was the best screened Iowa and Illinois lump, while that burned at our power house was the cheapest and the dirtiest Iowa slack or steam coal, and for the further reason that the principal part of this electric service was performed upon the city streets where cars were stopping and starting every few hundred feet and no benefit was derived from momentum. In other words, the same condition exists as though a locomotive was working on an

*Extracts from a paper by Mr. L. S. Cass, President and General Manager, Waterloo, Cedar Falls & Northern, read at the December meeting of the Iowa Railway Club.

up grade under full tonnage for its entire trip.

The service engaged in by switching locomotives comes somewhat nearer a comparison with the condition existing on most electric railroads. Our steam locomotives, when engaged in switching service, consume .30 tons of lump coal per hour, while our street cars require but .12 tons of slack coal per hour. The average weight of street cars is about one-third that of switching engines, so it would be entirely fair to multiply the .12 tons per hour by 3, or .36 tons per hour, consumed by electric cars of steam switch engine tonnage. We should divide the .36 tons per hour by 2, as the quality of coal used by the electric cars is not one-half as good, and does not cost one-half as much as that used by the steam switch engine. We find then the result to be .18 tons per hour, or a saving of .12 tons per hour by the concentration of energy in a central station, and in addition the saving of one man on the locomotive.

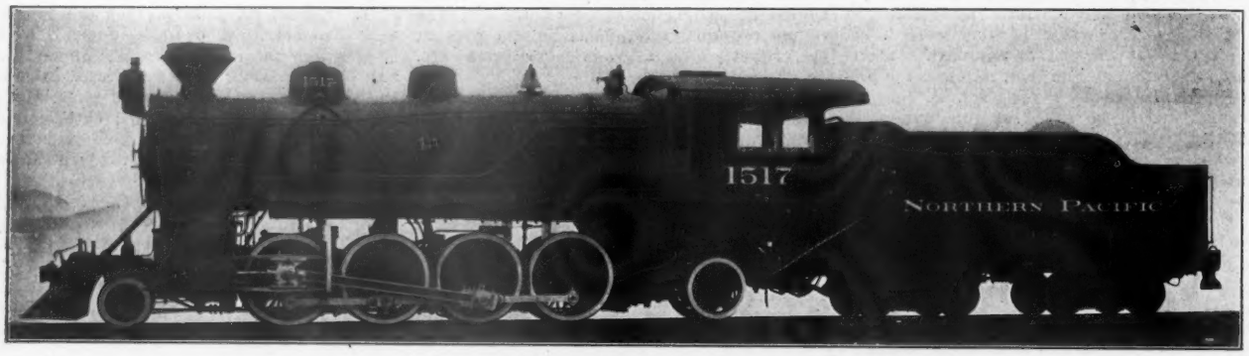
The cost of equipping a steam road with the necessary electrical conductors, power house sub-stations, etc., is an item of no small moment, and, of course, depends upon the requirements of the line to be equipped. The minimum for small lines is $3,000 per mile. Then after the road has been prepared for operation by electricity, the motive power and electric coaches will cost as much as the same power in steam equipment; therefore, the cost of this maintenance must be added to the present maintenance account and the interest charged to the added cost of installation. Anyone can now estimate whether trains operated by electricity will increase the revenue and decrease the operating cost sufficiently to warrant the expenditure. All the labor saved on a train would be one fireman, and to offset this a high-salaried inspector must be kept in the locomotive house to look after the intricate electric machinery under the cars.

I do not see where any additional revenue will be derived from freight traffic, and the only way passenger traffic would be increased would be by stopping at cross-roads and entering upon the important streets in towns, as is done by purely electric passenger lines. That you could not afford to stop heavy and through passenger trains for this purpose goes without saying, therefore there is no reason to expect the increase from such source. You say: "Let us put on single cars and run them frequently." Under the standard code of rules you do not permit a passenger train to stop between stations, without protecting the rear of the train with a flagman, equipped with the necessary appliances. Is it not just as necessary to protect the rear of a single car when stopped between stations, and would you consider your passengers safe in a car stopped at cross-roads on the same track with limited trains? Without this, then, where will the passenger revenue be increased?

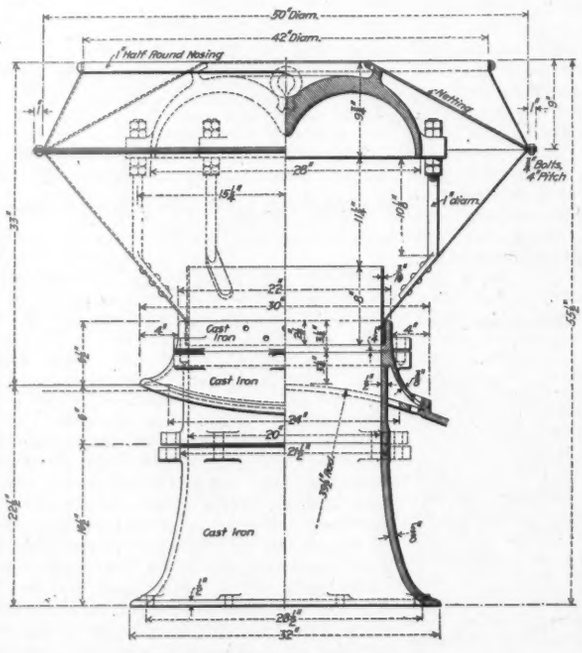
The present overhead system of an electric railway is a menace to the safety of trainmen whose duties require them to go on top of freight cars and the third rail is prohibitive in switching yards on account of the danger to switchmen and other pedestrians. The short circuit is another one of the great objections of using electricity for motive power on trunk lines, for when it occurs the circuit breaker opens at the power house and cuts off the supply of current at each motor in the section of track affected. It stops every train, puts out all the lights, and cuts off the supply of heat.

It is true an electric engine is a very comfortable machine to run; the motorman can wear a white shirt and Prince Albert coat, and when he shuts off the controller the expenditure of power stops at once. The greatest advantage, however, in the application of electricity to steam roads, as applied with the present perfected electric apparatus is summed up in four words—no smoke, no smell.

There is no question but that there is a great field in which electricity can operate, and a great demand for electric transportation in the sections through which most of the trunk lines operate, but that demand should be met by providing the class of transportation which the local conditions require. From the time that electric railroads entered the field of modern transportation they have been bitterly opposed by most of the trunk lines. It is true that in the beginning this attitude was consistent, but with the continual building up of these small lines, it is certainly foolish, to say the least, for the trunk lines to maintain an established erroneous policy and continue to refuse to enter into traffic arrangements with an electric railroad just because it is an electric railroad. In these days of keen, and even fierce competition, a policy, which refuses to accept a pound of freight or a passenger because it is presented by an institution against which trunk lines hold an ancient and honorable grudge, is certainly an error.



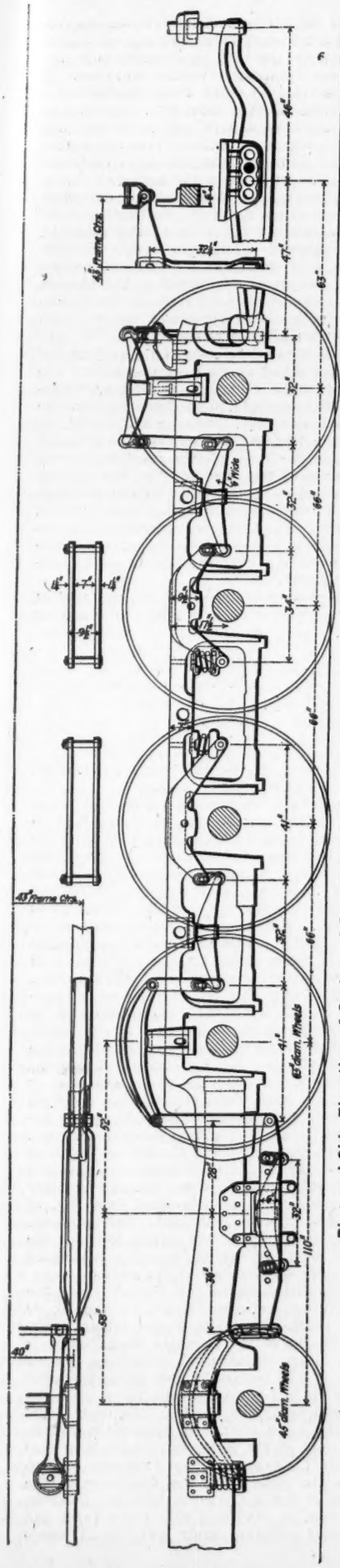
Mikado (2-8-2) Locomotive, Northern Pacific.



Detail of Diamond Stack.

Mikado (2-8-2) Locomotive for the Northern Pacific.

The Northern Pacific has recently received from the Brooks works of the American Locomotive Company 19 Mikado (2-8-2) type simple engines and six tandem compounds with the same wheel arrangement and same weight. These engines are not quite as heavy as the Baldwin 2-8-2 type engines built for the Santa Fe two years ago, which weighed 260,000 lbs. with 200,000 lbs. on drivers without the traction increaser with which they were equipped being in use. The Northern Pacific locomotives weigh 259,000 lbs., with 196,000 lbs. on drivers, and are the heaviest engines in use on that road. They are running in a district where the water is bad, and particular attention has been paid to the design of the boiler to insure good circulation and free steaming. In comparison with the Santa Fe locomotives the heating surface is small, being only 4,007 sq. ft. as against 5,366 sq. ft. This difference is almost entirely in the tubes, the Northern Pacific engines having 374 2-in. tubes with 3,798 sq. ft. of heating surface, and the Santa Fe engines 463 2¼-in. tubes with 5,156 sq. ft. As the sizes of the boilers are almost the same it will be seen how much more water and steam space has been provided in the later engine with a view to affording better circulation. The fire-box water spaces are



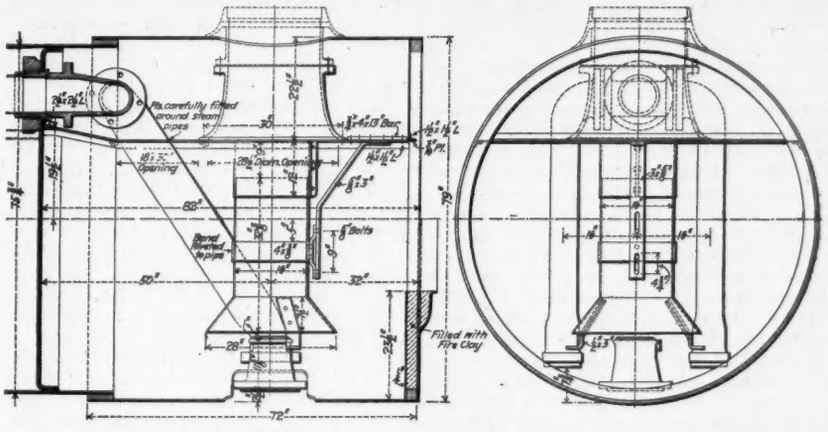
Plan and Side Elevation of System of Equalizing Springs and Levers, Northern Pacific Mikado (2-8-2) Locomotive.

also liberal, and the steam dome has been mounted on the second ring to further prevent foaming. These engines represent a return to rational boiler design, more attention having been paid to circulation and effective heating surface than to an effort to obtain the maximum possible heating surface regardless of efficiency.

A number of other details of the design are of interest. The fuel used in the district where these engines run is a Montana bituminous coal which is light, easily broken and burns with large quantities of sparks. For this reason a diamond stack and low nozzle has been applied and the details of the front-end arrangement are shown in the accompanying drawings. This arrangement differs in some important respects from the standard on the Union Pacific, about the only road now using the diamond stack. The common form of front-end for a diamond stack is short with the nozzle placed close to the tube sheet, but in this arrangement the center of the nozzle is 50 in. from the tube sheet and 32 in. from the front end. The effective volume of the smoke-box has been reduced nearly one-fourth by putting in a plate 22½ in. from top extending the length and width of the smoke-box, but an opening 18 in. x 30 in. is cut in this plate between the branch pipes and the inner stack to give access to the gaskets and joints in the branch pipes. The petticoat pipe extends low down to within 1 in. of the top of the nozzle, but it can be adjusted in height through 4 in. It is 16 in. in diameter and is flared at the bottom to 28 in., which is the same diameter as the base of the inside stack. There are no baffle plates, diaphragms or netting in the smoke-box, and the gases have an unrestricted opening into the stack.

The stack is cast iron, 20 in. in diameter in the straight part and flared at the bottom to 28½ in. It extends down to the diaphragm across the top of the smoke-box and 5½ in. up into the diamond cap. The sheet steel diamond cap is 50 in. in diameter at the largest part and 42 in. in diameter across the top. The deflector in the top is in the shape of an inverted half-cylindrical ring and is supported over the opening of the stack with six brackets riveted to the base of the diamond. A ring of 3 x 3 netting is put in across the opening between the angle of the diamond and the top of the deflector to prevent large sparks which have not been broken up by the deflector from being thrown out of the stack. The whole front-end arrangement seems to be well proportioned and designed not not only as a spark arrester but as a draft appliance, and the results in service should prove interesting.

The total wheel base of these engines is quite long, 34 ft. 9 in., although the rigid wheel base of 16 ft. 6 in. is not excessive. A somewhat unusual arrangement of equalizers has been introduced which divides the total weight into two separate units of two drivers and a truck wheel on each side. The forward wheels are equalized with a coil spring over the leading truck wheel box, a long equalizer bar under the saddle, a half-elliptic spring over the forward driver box, an inverted half-elliptic spring under the top bar of the frame between the first and second drivers, a U-shaped yoke over the second driving box, and a coil spring between the top and bottom bars of the frame back of the second driver. The rear wheels have a coil spring in front of the third driver, a U-shaped yoke over the third driving box, an inverted half-elliptic spring between the third and rear drivers, a cast steel yoke over the rear driver above the frame, a long equalizing bar pivoted through a half-elliptic spring to the front end of the auxilliary slab truck frame, a yoke over the rear truck wheel inside of the frame and a coil spring attached to a bracket riveted to the inside of the truck frame. The engines have improved



Cross-Section and End Elevation of Smoke Box, Northern Pacific (2-8-2) Locomotive.

Player radial leading and trailing trucks. Some of the principal dimensions follow:

General Dimensions.

Wheel base of engine, total	34 ft. 9 in.
Wheel base, driving	16 " 6 "
Wheel base, rigid	16 " 6 "
Heating surface, firebox	200 sq. ft.
Heating surface, tubes	3,798 sq. ft.
Heating surface, arch tubes	9 "
Heating surface, total	4,007 "
Grate area	43.5 "

Wheels and Journals.

Drivers, number	8
Drivers, diameter	63 in.
Leading truck wheels, diameter	33 "
Trailing truck wheels, diameter	45 "
Journals, driving axle, main	10x12 "
Journals, driving axles, others	9½x12 "
Journals, leading truck	6½x12 "
Journals, trailing truck	8x14 "

Cylinders.

Diameter	24 in.
Stroke	30 "

Valves.

Type	Piston
Travel	5⅝ in.

Boiler.

Type of	Extended wagon top
Working steam pressure	200 lbs.
Diameter	75⅝
Crown stays	1-in. radial
Fuel	Bituminous coal

Firebox.

Length	97 in.
Width	66 "
Thickness of sheets	Sides, ⅝-in.; back, ⅝-in.; tube, ½-in.; crown, ½-in.
Water space	Front, 4½ in.; back, 4 in.; sides, 4 in.
Grate	Rocking

Tubes.

Number	374
Material	Iron
Length	19 ft. 6 in.
Diameter	2 in.
Wire gage	No. 11

Tender.

Style of tank	Water bottom
Capacity, water	6,000 gal.
Capacity, coal	12 tons
Wheels, diameter	33 in.
Weight in working order	146,500

Rails for Lines With Fast Trains.*

BY P. H. DUDLEY.

(*Continued from page 32.*)

Chapter V. considers the manufacture and inspection of steel rails in American rolling mills.

(a) *Steel.*—Acid Bessemer steel is almost universally used for rails in the United States. Some small quantities of basic Bessemer steel rails have been laid but no information is obtainable as to the results obtained in service. The Tennessee Coal & Iron Company is the only company making basic Bessemer rails in this country, but some few were imported for trial last year. Open hearth steel has been used in making rails for service tests and it is said to have given results equal or superior to Bessemer steel in wearing qualities, but no details are obtainable.

After recarburizing the bath, the metal is poured directly into the teeming ladle at all the mills in the United States with the exception of the Illinois Steel Company's plant at South Chicago. At this works the metal is poured into an intermediate ladle. The advantages of this method are that the metal is mixed more uniformly than when poured directly into the teeming ladle and the entire mass of metal is affected, the gas and slag being liberated much more effectively than when the ladle is stirred with a green wood pole. Any practice which contributes to a sound ingot is of first importance.

(b) *Ingots.*—In mill practice, great changes have been made, in the last two decades, to furnish the output of rails required. Ten years ago, one million or 1¼ million tons per year was a large product for the rail mills of this country. Since the introduction of the stiffer sections, the tonnage produced has been more than doubled, nearly trebled. In 1900, the output of steel rails from the mills was 2,383,654 tons; in 1901, 2,870,816 tons; in 1902, 2,935,392 tons. This did not supply all the rails required, and some were imported.

To make the large tonnage required all the rail mills have been modernized. The converters for blowing the steel have been enlarged from five to 15 or 20 tons. Steel mills built in 1873 for an output of 60,000 tons yer year (considered a large product at that time), have all been superseded by those which can turn out a greater number of tons per month. The size of the ingots has been increasing constantly in the past few years, a necessity for the tonnage required.

Dimensions and Weight of Ingots.

	Name of steel company					
	Carnegie.	Cambria.	Lackawanna.	Maryland.	Pennsylvania.	Illinois.
Size on top, in.	15x17	16x19	16x16	18x19	16x16	16½x17 7/16
Size on base, in.	17½x19½	20x23	18x18	20x21	17x17	17¾x19¾
Length	5 to 6 ft.	6 ft. 2 in	6 ft.	5 ft.	5 ft. 6 in.	6 ft.
Weight, in lbs.	4,600 to 5,000	6,500 to 7,200	4,800 to 5,200	5,420 to 6,080	4,000	6,400
No. per heat	8	4	6	6 to 8	5 to 6	5 to 6

The ingots are all teemed in moulds on cars, stripped by mechanical strippers, and handled automatically, all of which contribute to the output. Pits have been discarded at all the rail mills in the United States. Since the introduction of the teeming of the ingots on cars, the draught of the moulds at some mills formerly in use for pit casting, have been reduced so that their size on the top is now about 2 in. less than on the base, for those 5½ or 6 ft. long. This is advantageous, as the escaping gases are not entangled as readily in the columnar structure at their corners, and the top and the butt rail of the ingot are more uniform in quality. The metal cools most rapidly from the sides of the ingot mould, producing a decided columnar structure, 1 in. to 2 in. thick, at right angles to the sides. In the rectangular or square corners, the columnar structure from the sides meet at an angle of 45 deg., and escaping gases and impurities from the setting steel are often entangled, causing slight unsoundness or porosity of the metal near the corners of the ingots. As the metal cools in the mould, it forces the impurities not entangled toward the fluid portion in the center of the ingot.

There are two or more grades of ingots which may be produced, depending upon the chemical composition. One sets solid, with a tendency to form a central pipe, in which there is an absence of the secondary zone of blow holes. The only gases sometimes retained are those mentioned as being checked in liberation. Other grades of ingots are those in which the steel rises after being teemed in the moulds, and a secondary zone of blow holes is liable to be formed between the columnar and ordinary structure of the steel. A pipe rarely occurs in these grades, but the entire metal has considerable porosity.

In the early manufacture of the Bessemer steel rails, with small percentages of carbon and manganese, ingots with small blow holes were often produced, and when the surfaces were not oxidized, they became welded partially or completely, in the subsequent process of manufacture, especially when they were hammered by heavy steam hammers. With the higher grades of steel in use at the present time, and the more rapid methods of manufacture, the blow holes or sponginess of the ingot, are not welded, but become elongated in blooming and rolling, and when this is the case, a weakness develops in the inside upper corner of the rail heads in service. The wheel pressures are now so great, that after a wear of one, two or more years, the metal becomes detached, and flakes off from the upper corners of the head of some rails. Instances are seen also where the unsound metal breaks out—"detrusion"—on the inside edges of the head, and is rolled out into thin flakes by the wheels. The top rail from the ingot as a rule shows the flaking and "detrusion" more decidedly than the succeeding rails rolled from the same ingot, though in cases all except the butt rail are affected. It is not alone a question of the chemical composition of the metal for the rails, but the solidity of the metal and absence of porosity, slag and oxides of the bath retained in the corners and central portions of the ingot.

The universal practice of heating the ingots in modern rail mills is in vertical gas-fired furnaces, which in a measure correspond to the soaking pits of a few years ago. At the Maryland Steel Company the furnaces admit only four ingots, and the air and gas supply is so controlled that the heater can heat only at a certain rate, and is not at liberty to control the amount of gas and air supplied to the furnace at any given instant, which is regulated automatically by the mill superintendent.

The proper heating of the ingot produces a gradual equalizing of its interior heat and that supplied to its exterior portion in the furnace. The walls of the furnace are hot, and by a moderate supply of gas and air, the heat equalizes through the mass, as the interior portion solidifies. It requires from 35 to 45 minutes to equalize the heat in an ingot about 6 ft. long, 20 x 22 in. on the base, and 18 x 20 in. on the top. The heating is so gradual that the cinder does not drip from any portion of the ingot when it is drawn from the furnace to go to the blooming mill. The ingots are retained in a vertical position from the teeming, until after equalizing the heat in the furnaces, being charged while the center is still molten, and by reasonable chemical composition, and proper cropping of the blooms, the percentage of piped raills is small compared with the rails rolled from ingots which were allowed to cool.

(c) *Rolling.*—The rails at the majority of mills are rolled direct from the ingot. The Cambria Steel Company, the Edgar Thomson Mill, Carnegie Steel Company and the Pennsylvania Steel Company at Steelton, reheat the blooms. It is ideal, theoretically to reheat the blooms to the refining temperature only of the steel for the final rolling of the rail, but reheating to the temperature of coarse structure, as is usually done, is injurious rather than beneficial. The direct rolled rails are the stiffest under the drop tests, and have the highest elastic limits, as a rule.

The number of passes in the rail mill at different plants is shown by the following table:

	No. of passes				
Name of steel company.	Blooming train.	Roughing train.	Intermediate train.	Finishing train.	Total No.
Carnegie	9	5	5	1	20
Cambria	15	7	3	2	27
Lackawanna	6	4	5	1	16
Maryland	13	6	4	1	24
Pennsylvania	9	6	..	5	20
Illinois	9	3	2	4	18

The speed of the finishing trains ranges from 480 to 600 ft. per minute.

Two of the steel mills use cooling tables upon which four or six rails are held to cool, according to their weight, so that the finishing pass will be rolled at a reduced temperature, to make the structure of the metal finer than was obtained before the modern practice of colder rolling was adopted. The cellular structure obtained by this practice differs essentially in character from the non-cellular structure secured in the first light sections of Bessemer rails. Some of the cold rolled rails are irregularly cooled, retaining high initial strains, and fractures have occurred in the track, which have been traced directly to injuries due to the process as practiced. These can be overcome, doubtless, as experience is gained in such work, but it is not a simple problem. The recent short independent finishing trains, for the final pass are two-high, but not reversible, and the fishing angles of the section can be made more perfect in the short rolls, than in those having a number of passes. The Illinois Steel Company, at Chicago, and the Maryland Steel Company, at Sparrows Point, use chilled rolls for the short finishing trains, securing a smooth finish on the exterior of the section.

The shrinkage at the hot saws for the cold rolled rails is 5¾ in. for the 80, 90 and 100-lb. 33-ft. rails, at the Edgar Thomson Works of the Carnegie Steel Company. The larger sections are delayed a longer time to cool before the final pass. For ordinary rolling the shrinkage for a 33-ft. 80-lb. rail is 6½ to 7½ in. The early 56-lb. section for a 30-ft. rail, required a shrinkage only of 4¼ to 4¾ in. At the new mill of the Lackawanna Steel Company at Buffalo, the time from the first pass of the ingot to the hot saws is from six to seven minutes, as compared with about three and one-half minutes, rarely four, for 13 passes

*Abstract of report to be presented to the International Railway Congress, May, 1905.

from the ingot to the finished section, with a smaller ingot, which was required in their former mill at Scranton, Pa., ten years ago. The longer time taken in passing a single rail through the mill improves its quality while passing two or more rails through the trains of rolls at the same time does not restrict the output.

The converting department must have close attention from the manufacturer if not from the inspector, if the proper chemical composition and sound ingots are to be secured. It requires unusual skill on the part of an inspector to understand mill practice and reliance must be placed largely on the reputation of the steel maker.

In blowing the bath in the converter, it should be under rather than over blown to prevent reducing the manganese and silicon below the normal content intended for the steel. It is often claimed that with a low content of manganese or silicon the oxides are not always reduced and that they remain in portions of the steel as impurities. In some recent high-carbon rails, analysis of the resulting product did not indicate a trace of oxides with the slag which was determined as .11 per cent. There is often a large percentage of slag in the upper corners of the head and in the web of some rails resulting in defects developing rapidly when the rails are put in the track. This is because the ingots from which the rails were rolled were not sound and homogeneous throughout.

Recarburizing the bath is an important step in the process of manufacture since it insures a complete reaction and mixture of the spiegeleisen in the steel. Segregation of the metals and metalloids in cooling ingots results from imperfect mixing. The best specifications refer to the teeming of the ingots and this feature should receive careful attention. Unsound ingots, which are rarely found in present practice, should be rejected wholly.

Equalizing or controlling the heat in the ingots is a requisite in the manufacture of good rails, and is a question of time, instead of rapid firing, the firing being under intelligent control. This advanced practice results in an improvement in the quality of the steel, and a reduction of the "Seconds."

Blooming the ingots should be covered by the inspection, as the steel may be injured by too rapid and heavy passes in the "blooming train," before it is strong enough for the work. The structure of the metal in the hot ingot is frangible and requires time to flow without cracking on the exterior surfaces or the interior portions, the effects being noticeable in the service in the track of the rails from some mills. Ingots which are too hot crack in the columnar structure, and do not weld in the subsequent passes. If these surface cracks do not roll out, they form minute seams or flaws, and except in the heads or base may be closed so completely as to escape inspection at the mills in the finished rail. The structure known as "Non-granular" or "Non-cellular" is produced by attention to the reduction of the heat in the blooming, before reaching the roughing and finishing train. A similar texture has not been found in the finished rails, in which attention is paid only to cooling the bar just previous to the last pass. The old light rails which were considered to have such desirable qualities, were all bloomed from ingots at low temperatures, by steam hammers, but were not reheated to as high a temperature as has been the general practice for the larger sections. In a blooming train with several passes and light reductions, a rapid dissipation of the heat is effected, which is advantageous for the resulting product in the rails.

The drop test in the manufacture of rails had almost become obsolete, prior to the introduction of the heavier sections, and was reinstated in practice by the author in making up the specifications for the first high carbon rails. The mills, in their general specifications, provide only for one drop test from every fifth heat, which represents but one rail out of every 80 or 90 of the output. A drop test from each heat, provided the deflection and the elongation are noted, is sufficient to determine the physical properties of the rail, and assists in the manufacture. When the drop tests are made promptly, the conversion of the steel can be followed within a few hours, and slight corrections necessary to be made in the chemical composition, due to changes in the weather, are at once known. The drop test will detect instantly a reduction in the manganese in the steel, due to the approach of a storm.

It is necessary to ascertain the toughness of the metal as a matter of safety. The American Railway Engineering and Maintenance of Way Association has recommended that a drop test be made from each heat, as the least which should be accepted. Such tests can be made so quickly without any machine work on the rail butt that the physical properties of the steel can be ascertained almost at once without delaying or restricting the output. Other methods of testing do not furnish the same knowledge as promptly for application during manufacture as that furnished by the drop test. By stamping the flange with marks one inch apart before testing, the elongation of the metal can be measured under definite stresses. The drop test compares in a measure to the severe shocks which the rail endures in service under fast trains. Steel of coarse texture will break under the drop test, or in the track, and it indicates something abnormal in the composition of heating of the ingots or blooms when a break occurs.

Chapter VII. considers the methods in use in rolling the rails in the finishing passes and straightening them before shipment. The section in the finishing passes being extended and shaped only by the pressure of the rolls sidewise, the top of the head in the parting of the rolls does not receive sufficient work to make it conform as a solid, dense structure with the contour of the section. In rails from the same ingot or bloom, the butt section often shows a slight over fill, while the top rail may not be full to the curve. The variation is not uniform and is often .015 to .020 or even .030 of an inch in height, nearly the limit allowed in rolling. These differences in new rails seem of little importance, but are augmented rapidly in service. The facing ends of the rails become unduly worn, and do not admit of surfacing. This would be improved if a roll were used in the train to apply pressure directly upon the surface of the head, as it does not receive it after the dummy pass of the intermediate or finishing train. The top of the head is raised and increased in height from each preceding pass, but decreased in density instead of being compressed as should be the case to consolidate the metal. This reduces the thickness of the columnar structure of the outside of the ingot to a mere shell on the surface of the head of the rail, and if there were blow holes or porosity of metal in the corners of the ingot, then a portion of the upper corner of the rail head often "flakes off" under heavy wheel loads. It is observed in cutting the rail sections by hand saws, that the upper ⅛ in. is softer than that below which has received the effect of the pressures of the rolls. The higher the standard of smoothness of track, the less difference in the height of adjacent rails is permissible. This variation should be under $^1/_{32}$ of an inch for ordinary track, and for high speed trains practically without variation. Standard measures used for designing sections and roll turning, also starting new rolls at the full height of the section, have contributed to reduce the variation due to the rolls.

The importance of straightening the rails to produce a smooth surface has not been appreciated until recently by the mills. Several mechanical methods of straightening the rails have been devised, but as yet they are not sufficiently rapid for the output. Decided improvement has been made in straightening the stiff rails by increasing the width of the supports on the anvil blocks of the presses. The light rails were straightened on supports only 18 to 20 in. apart. For the stiffer rails, which require more force to straighten them—unless the span of the supports is increased—the span has been made 36 to 40 in. This reduces the pressure to be applied almost in the inverse ratio of the cube of the span of the supports—about one-seventh or one-eighth—and when the work is performed skilfully, the surface of the rail is without deep indentations from the gags. This gives smoother finished rails. The modern designs of balanced rail sections which require less camber and movement during recalescence on the hot beds, need less pressure to straighten them and have a better surface than the old light rails. The first 5-in., 80-lb. rails of the New York Central were all heavily gagged and made wavy on narrow spaced supports. They could not be surfaced smoothly and were eventually removed from the main line.

A method should be devised by which the surface of the rails can be straightened without as severe work in the presses as is now the case, even with wide supports. Large initial stresses are left in the rails where a permanent set has been made in the metal to straighten the section. Many rails are damaged in this way and when put in the track failures develop rapidly.

Shearing stresses in the webs of the rails under fast trains are much greater than are usually supposed, and several cases have occurred where checks have developed leading to ultimate failures. The author has twice observed the progressive development of these checks in the webs of rails in track. The checks are nearly parallel to the neutral axis of the section and are the result of undue shearing stresses. This difficulty will be magnified with cold rolled rails.

In the track, wavy rails from excessive gagging in finishing produce unsteady riding of the cars and locomotive and the trackmen are unable to correct the irregularities in the surface of the rail which increase with wear and require renewal of the rails before they are fully worn out.

(To be Continued.)

Carbonic Acid Gas for Signals.

BY P. G. TEN EYCK.

Carbonic acid gas, more properly spoken of as carbonic anhydride or carbon dioxide (CO_2), is a colorless gaseous non-combustible compound which forms about $^1/_{2500}$ or .0004 of the volume of the atmosphere. It is 22 times as heavy as hydrogen and is composed of 12 parts carbon and 32 parts oxygen by weight. It can be reduced to a liquid by great pressure and cold.

At about 80 deg. Fahr. under approximately 1,200 lbs. pressure per sq. in., it will liquify; and when in the liquid state, if allowed to evaporate or expand suddenly, it will congeal into a white solid, which if touched to the bare skin will burn, or properly speaking, freeze that part of the skin with which it is brought in contact. It is poisonous if inhaled, but has a pleasant taste

and is not poisonous if taken into the stomach.

Its use in the arts has become extensive. It is used for enlivening beverages and mineral waters and as a fire extinguisher. It has been proved on ship board that if the atmosphere in a room has 25 per cent. of carbon dioxide, combustion will not be supported. It is used in a certain process for dyeing.

Last but not least, it is used under compression as a power for operating semaphore signals. For signal propulsion it is used as a gas at about 40 to 50 lbs. pressure per sq. in. It is transported and stored in tanks in liquid form, and is allowed to expand into a gas in a secondary or auxiliary chamber before using. Its use for signals has passed the experimental stage, and it is now being used extensively. One of the principal arguments in its favor is the simplicity of the signal mechanism required, also that it is self-contained.

The operating power on the signal can be increased or diminished as the case may demand by merely turning a reducing valve. The carbonic acid gas signal was invented by C. J. Coleman, of the Hall Signal Company, in 1900, and a full description of the mechanism is given in circular No. 5 issued by the Hall Company, and also in the *Railroad Gazette* of June 5, 1903.

Carbon dioxide was first produced commercially in the United States in 1885. Since then over 35 factories have been established of which the annual output is over 30 million pounds. Several processes for producing the gas are in use. First.—From carbonate of magnesia which is imported from Greece.

This is put into retorts and coke is used as a fuel to expell the gas. Second, the gas is produced in the fermentation of beer. The vats are closed and the gas is drawn off by suction pumps. A third process is the action of sulphuric acid on a carbonate, such as marble dust. The fourth and most advanced method of artificial production is by the burning of coke. The gas is absorbed from the product of combustion by a strong solution of carbonate of potash, forming a bicarbonate. The heat from the coke is used to drive off or free the CO_2 from the bicarbonate solution which is under pressure; after the CO_2 is expelled the potash solution can be used again.

The process which is used at Saratoga, N. Y., for securing the gas from the natural carbonic waters issuing from the ground was explained to me by Mr. J. C. Minor, of the New York Carbonic Acid Gas Company, whose works are fitted up to supply the kind and quality of gas used in signals. By scientific methods physically and chemically pure and properly dried gas is produced.

A 6 in. well is drilled into the earth. If successful, gas and water will spout forth when limestone is reached, which is at a depth of from 200 ft. to 600 ft., though in some cases the flow is produced by forcing compressed carbonic acid into the well, on the principal of the air lift. The water and gas then lifted is allowed to run into a hogshead. In this the gas will separate from the water and fill the upper part of the cask, and from thence it is forced through a purifier, composed of oxide of iron flakes, to the gasometer; again through a purifier, and then through calcium chloride vats. This completely dehydrates the gas. From here it is taken to the compressor, which compresses it to 60 lbs., next it is compressed to 300 lbs., and later to 1,000 lbs. When compressed it is allowed to flow into the tanks direct from the compressor through a small auxiliary reservoir. The tanks are placed on scales near the compressor and as soon as the proper or required amount has entered the tank, the gas is shut off and the tank removed, and a new one is put in its place. It takes eight or nine minutes to fill a tank. All the gas tanks are tested, cleaned and dried before filling.

The difficulties which have been experienced with gas in signals have been due to lack of cleanliness or to poor gas. If dirt or scale gets on the hard rubber disk in the valve seat it will cause the valve to seat improperly, due to the rough surface. A metal valve seat may be damaged by gas containing foreign impurities which, when dissolved by the moisture in the gas, will rust or eat into the metal, causing a rough seat. The accumulation of water at the small opening in the valve seat in cold weather will freeze, thus shutting off the supply to the cylinder. This can be detected by a lowering of the pressure on the lower pressure gage while the high pressure gage remains unchanged. This is also entirely due to the poor quality of the gas used.

If a gage is taken apart to repair a valve seat it must be tested after reassembling by submerging the regulating valve in gasoline up to the gage and turning on gas at a pressure of not less than 75 lbs., after which it must be connected up in multiple with another standard or test gage to test the reading.

The storing of carbon dioxide in drums is an important matter and the maintenance of the purity of the gas is an important part of gas signal work. All tanks or cylinders used to store or to transport gas for signal work should be made seamless, from open hearth steel, of a uniform size, 8 in. x 50 in., capable of holding 88 lbs. of water, the formula for the metal being: Silicon .081, sulphur .020, phosphorus .020, manganese .45 to .75, carbon .42 to .58, iron to make up the remainder.

The metal should have an elastic limit of 53,000 lbs. per sq. in., and a tensile strength of 97,000 lbs. per sq. in., and the tank should be subjected to a cold water test at 3,800 lbs. per sq. in.

The following table shows the pressure of the gas at different temperatures in an 88-lb. tank which contains 50 lbs. of gas: Dimensions of cylinder, 8 in. x 50 in.; water capacity in lbs., 88 lbs.; ordinary gas contents, 50 lbs.; density of proportion of filling, 57.

Temperatures and Pressures.

60°..745 lbs.	110°..1,475 lbs.	140°..2,065 lbs.
80°..966 lbs.	130°..1,865 lbs.	

At no time should one of these tanks be filled with more than 60 lbs. of gas. At 130 deg. F. this tank will have a factor of safety of 2.6. The above tubes by actual tests have shown that they will burst at a pressure of from 5,000 to 6,000 lbs. per sq. in., which shows conclusively that the above specified tanks are safe under the worst conditions of heat outside of actually being in a fire.

It should be a rule that no tank of CO_2 should have more than .35 per cent. of moisture in it and not have more than 3 per cent. of air in the tank after filling. All valves on tanks must be closed when taken out of service and kept closed until returned to factory.

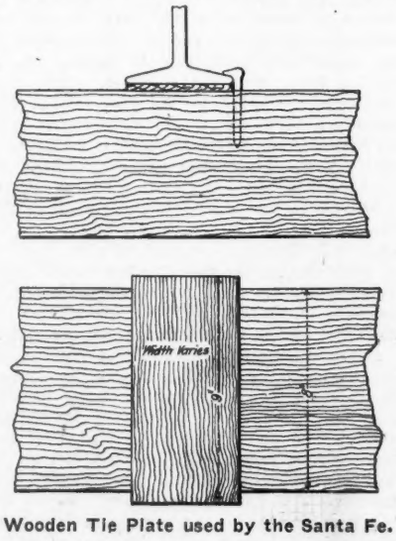
All tanks should be given a suds, water, or oil test after being filled at the factory and the date of the test be noted on a card attached to the tank. Working rules require the same test to be made at the storehouse of the railroad when received, also when sent out. The repairman must also test it when it is put in service, and at stated intervals of not more than a week. All cap nuts must be so ground that there will be no leak when the cap is on and the valve is wide open. When the valve is opened it must be turned as far as possible so as to close the back seat. This should be tightened again within three or four days and at each inspection thereafter.

Before a tank is connected to a signal, the valve must be opened and closed to blow out all scale. The cap nuts for covering the main valve should be made to fit the safety valve, so that when the tank is put in service and the cap nut is taken off, it can be put on the safety valve. This forms a protection against leakage while the tank is in use and incidentally keeps the cap from being lost.

When a tank is received by a railroad storekeeper he weighs it. It should again be weighed before being put in service, and weighed when empty. Valves and gages must be kept wrapped up in paper when not in use or when on the road in transit, so as to keep out dust particles.

Wooden Tie Plates on the Santa Fe.

About a year ago (February, 1904) the Santa Fe began in an experimental way the use of wooden tie plates for the protection of softwood ties. A few plates made from cypress were placed on cypress ties on the Texas lines, these ties being easily damaged by rail cutting, while so far as service in other respects is concerned, they give the best results in a country like Southern Texas. The experiment was so satisfactory that at the end of nine months it was decided to extend it, and cypress plates were ordered for 40 miles of track south of Sealy (about 100 miles north of Galveston), and five miles of



Wooden Tie Plate used by the Santa Fe.

gum and elm plates for use on pine ties on the Beaumont division. These plates are not yet in the track but are to be placed as fast as possible.

The plates cost new about one-third of a cent apiece and their life is about two years, judging by the present condition of those already in the track. The width of the plates will vary with the weight and size of rail, and the thickness is ¼ in. or ⅜ in., depending upon circumstances. They are slipped lengthwise under the rail and toe-nailed at each end with small galvanized nails to keep them from slipping out.

The test is also being extended to the main line, and 3,000 plates are being sent to each roadmaster between Chicago and Albuquerque in order to obtain results under all the varying conditions to be met in so long a mileage.

The Belgian Railroad Minister has said that there are no less than 6,227 crossings at grade in the country, or nearly one for every half-mile. Of these, 4,217 have gates and guards.

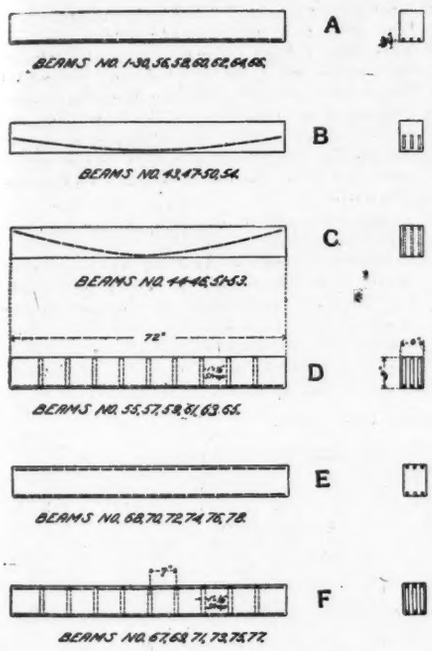


Fig. 1—Arrangement of Steel in Beams.

Tests of Reinforced Concrete Beams.*

The size of the beams and the various methods of reinforcing them are shown in Fig. 1. Photographs showing the different forms of failure are reproduced herewith. From each batch of concrete two prisms were made which were sent to the Watertown Arsenal to be tested. The results are tabulated in table 1. Other data is given in the accompanying illustra-

Table 1.—Tests of Concrete Prisms, 8x8x12 Ins.

No. of prism.	Age in days.	Crushing strength in lbs. per sq. in.	No. of beams made from same batch of concrete.
1 } 2 }	87	{ 4,680 } { 4,890 }	1-7
3 } 4 }	86	{ 4,330 } { 4,570 }	8-12
5 } 6 }	83	{ 2,940 } { 2,840 }	13-19
7 } 8 }	82	{ 3,650 } { 3,330 }	20-25
9 } 10 }	81	{ 3,650 } { 4,280 }	26-30
11 } 12 }	168	{ 5,680 } { 5,600 }	31-36
13 } 14 }	167	{ 4,150 } { 4,730 }	37-42
15 } 16 }	77	{ 3,550 } { 3,770 }	43-47
17 } 18 }	75	{ 3,430 } { 3,340 }	48-54
19 } 20 }	74	{ 4,590 } { 3,610 }	55-60
21 } 22 }	160	{ 4,100 } { 4,960 }	61-66
23 } 24 }	92	{ 3,420 } { 4,350 }	67-72
25 } 26 }	90	{ 4,630 } { 4,530 }	73-78

*From the tenth annual report of the Boston Transit Commission, H. A. Carson, Chief Engineer.

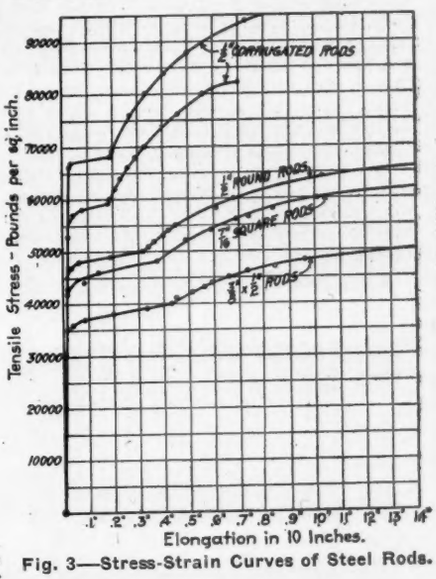


Fig. 3—Stress-Strain Curves of Steel Rods.

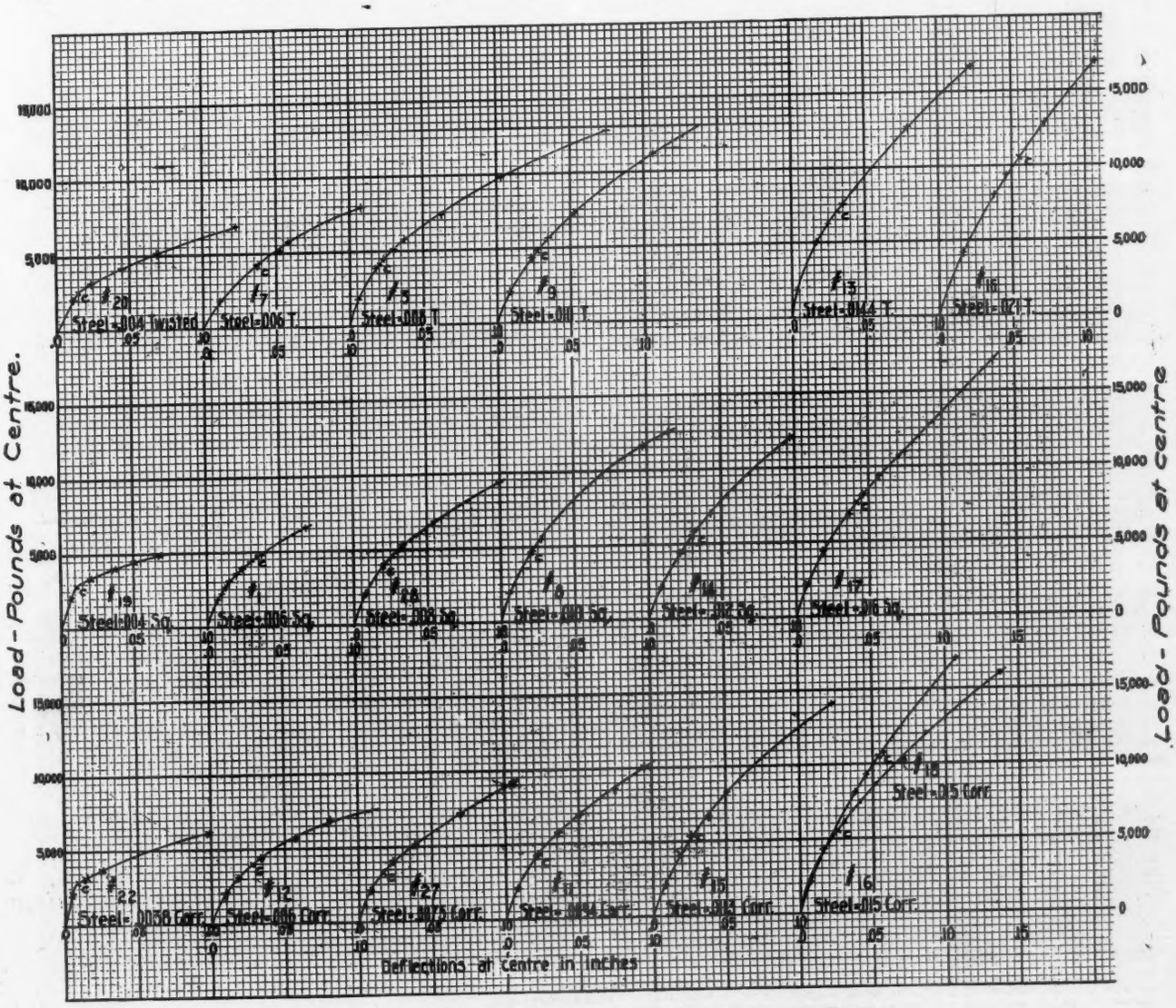


Fig. 2—Load-Deflection Curves of Reinforced Concrete Beams.

(Loads do not include weights of beams. "C" indicates first visible tension crack in concrete.)

tions and tables, showing deflections of beams, characteristics of the steel used for reinforcing, etc.

The beams and prisms were made in the proportion of 380 lbs. of Vulcanite cement, 4 cu. ft. of coarse sand, 4 cu. ft. of fine stone dust and 12 cu. ft. of broken stone. In mixing the materials and filling the moulds no attempt was made to secure better work than can be obtained in ordinary practice. The beams were left in the moulds about two days and then buried in damp sand until a few days before testing.

The average weight of the beams with small amounts of reinforcement was about 305 lbs. Those with larger amounts of steel weighed corresponding more. All loads were applied at the center. The loads given in the tables do not include the weights of the beams.

Measurements of deflections and sets were taken in nearly all cases, and were made as follows: Small brass plugs were set in the beams half way between the top and bottom above the supports and a fine German silver wire was stretched over them. At the center of the beams a small wood plug carrying a brass screw was set in just below the wire. The terminals of a battery with an electric bell in circuit were connected to the wire and to the brass screw. Measurements were then taken with a micrometer between the top of the wire and the bottom of the screw head, the electric bell making it possible to obtain quite accurate settings. Deflections were taken on both sides of the beams. The measurements were discontinued after the steel was stressed beyond the elastic limit.

The loads given in the tables as corresponding to the elastic limit of the steel are the loads at which the fine tension cracks in the concrete start to visibly open out and probably correspond to a tensile stress in the steel of from 2,000 to 4,000 lbs. per sq. in. in excess of the elastic limit.

The deflections of the beams reinforced

Table 2.—Tests of Steel Used for Concrete Steel Beams.

Kind.	Size.	Elastic limit.	Tensile strength.
Corrugated (Johnson)	½-in.	60,100	87,680
Twisted (Ransome)	7/16-in.	67,570	84,860
Twisted (Ransome)	7/16-in.	69,730	87,570
Thacher	9/16-in.	40,760	56,300

Table 3.—Tests of Reinforced Concrete Beams by the Boston Transit Commission.

No. of beam.	Age in days.	Steel reinforcement: No. of rods.	Size.	Area, sq. in.	Area, per ct.	Kind.	Load at first visible crack. (Lb. at center)	Sign of failure. (Lb. at center)	Ult. brkg load. (Lb. at center)	Failure similar to illustration of beam No.	First sign of failure.‡	Ultimate failure.	Remarks.
1	58	1 + 1	7/16 + 5/16	0.287	0.6	Square.	4,818	7,814	7,814	..	Tension.	Tension.	5/16" rod slipped in concrete at ult. load.
2	59	2	7/16	.382	.8	Square.	4,896	9,634	9,634	..	Tension.	"	One center crack opened.
3	59	2	7/16	.382	.8	Twisted.	4,190	11,446	13,066	15	Shear.	Shear.	Concrete splintered below rods.
4	56	2	½	.360	.75	Corrugated.	4,696	11,000	15,064	27	Tension.	Shear and tension.	Concrete slightly splintered near center below rods.
5	38	1	½	.180	.38	Corrugated.	3,000	6,500	8,180	..	"	Tension.	Concrete splintered below rod.
6	46	1	7/16	.191	.4	Twisted.	3,482	6,252	6,708	..	"	Tension.	Concrete splintered below rod.
7	51	1 + 1	7/16 + 5/16	.287	.6	Twisted.	4,436	9,088	11,556	27	"	Tension & shear.	Concrete splintered below rod, near center.
8	61	2	7/16	.478	1.0	Square.	4,670	10,190	10,190	..	"	Tension.	One center crack opened.
9	65	1 + 1	5/16 + 7/16	.478	1.0	Twisted.	4,776	13,350	13,350	16	Shear.	Shear.	
10	61	1 + 1	5/16 + 7/16	.191	.4	Square.	3,506	5,186	5,186	..	Tension.	Tension.	One center crack opened.
11	66	2½	½	.450	.94	Corrugated.	4,192	12,118	14,140	11	"	"	Concrete splintered below rods.
12	64	1½	½	.270	.6	Corrugated.	4,040	8,000	9,914	11	"	"	Concrete splintered below rods.
13	59	2 + 1	½ + 7/16	.691	1.44	Twisted.	7,030	19,026	19,026	16	Shear.	Shear.	
14	61	3	7/16	.573	1.2	Square.	5,600	13,714	13,714	..	Tension.	Tension.	One center crack opened.
15	68	3	½	.540	1.13	Corrugated.	5,404	14,540	15,036	15	Shear.	Shear.	
16	65	4	½	1.00	2.1	Twisted.	10,448	18,476	18,476	16	Shear.	Shear.	
17	67	4	7/16	.764	1.6	Square.	7,600	15,012	18,184	..	Tension.	Tension.	Shear cracks at ultimate load.
18	67	4	½	.720	1.5	Corrugated.	5,600	16,100	17,948	16	Shear.	Shear.	
19	68	1	7/16	.191	.4	Square.	2,980	4,020	5,160	..	Tension.	Tension.	One center crack opened.
20	68	1	7/16	.191	.4	Twisted.	2,800	8,332	8,926	11	"	"	Two center cracks opened.
21	68	1	½	.196	.41	Round.	2,716	5,004	5,230	..	"	"	Rod slipped in concrete at ultimate load.
22	67	1	½	.180	.38	Corrugated.	2,960	6,800	8,174	11	"	"	Concrete splintered below rod near center.
23	67	1	9/16	.248	.52	Thacher.	3,000	5,040	6,130	11	"	"	Two center cracks opened.
24	67	2	9/16	.496	1.03	Thacher.	3,680	10,304	12,422	11	"	"	Two center cracks opened.
25	70	2	7/16	.382	.8	Twisted.	3,126	9,306	12,576	15	"	Shear.	
26	70	1	½ x 3/8	.187	.39	Rectang'l'r.	3,680	5,086	5,086	..	"	Tension.	Center crack opened.
27	69	2	½	.360	.75	Corrugated.	3,126	10,500	13,236	27	"	Tension & shear.	Concrete splintered below rods.
28	72	2	½	.392	.82	Round.	3,788	10,312	10,312	..	"	Tension.	One center crack opened.
29	76	2	½ x 3/8	.374	.8	Rectang'l'r.	4,680	7,600	8,164	..	"	"	" " " "
30	72	2	7/16	.382	.8	Square.	3,640	10,456	10,456	..	"	"	" " " "
43	80	2	½†	.36	.75	B	3,126	14,528	16,384	44	"	Shear and tension.	
44	80	2	½†	.36	.75	C	4,134	12,682	16,202	44	"	"	
45	81	3	½†	.54	1.13	C	5,800	13,780	18,200	44	"	"	
46	81	4	½†	.72	1.5	C	4,136	15,920	20,736	27	"	Tension & crush'g.	
47	82	3	½†	.54	1.13	B	5,362	15,800	18,786	47	"	Shear.	Initial crack at top center of beam—down 5 in.
48	70	2	½†	.36	.75	B	4,880	13,400	16,984	27	"	Shear and tension.	
49	71	4	½†	.72	1.5	B	8,000	18,326	20,724	47	Shear.	Shear.	
50	74	3	½†	.54	1.13	B	4,156	15,616	19,240	27	Tension.	Tension & crush'g.	
51	73	2	½†	.36	.75	C	4,800	12,134	17,112	11	"	"	
52	67	3	½†	.54	1.13	C	4,492	14,496	17,896	52	"	Shear.	
53	103	4	½†	.72	1.5	C	4,480	21,444?	24,908?	52	"	"	
54	72	4	½†	.72	1.5	B	5,960	16,800	18,320	47	Shear.	"	
55	64	4	½†	.72	1.5	D	5,680	19,900	21,200	57	Tension.	Crushing.	
56	108	4	½†	.72	1.5	A	7,076	18,220	18,800	16	Shear.	Shear.	
57	63	3	½†	.54	1.13	D	6,454	14,486	18,300	57	Tension.	Crushing.	
58	109	3	½†	.54	1.13	A	5,864	17,280	18,204	15	"	Shear.	
59	64	2	½†	.36	.75	D	4,000	10,212	12,728	11	"	Tension.	
60	108	2	½†	.36	.75	A	3,720	10,000	12,944	60	"	Tension & shear.	Initial crack through beam 8-in. right of center.
61	109	4	½†	.72	1.5	D	6,856	18,000	23,556	61	"	Crushing.	
62	108	4	½†	.72	1.5	A	7,244	18,400	19,132	16	Tension and shear.	Shear.	
63	108	3	½†	.54	1.13	D	.....	15,204	17,876	11	Tension.	Tension & crush'g.	2 initial cracks through beam 15 in. right and 7 in. left of center.
64	109	3	½†	.54	1.13	A	5,284	14,000	15,680	64	Tension and shear.	Shear and tension.	Initial crack through beam 9 in. right of center.
65	109	2	½	.360	.75	D	7,000	16,584	21,628	44	Tension.	Shear and tension.	Initial crack through beam 14 in. left of center.
66	109	2	½	.36	.75	A	7,200	16,000	19,248	44	Shear.	"	Initial crack through beam 3 in. left of center.
67	95	8	½†	1.44	3.0	F	7,960	21,200	30,168	73	Tension.	Tension.	One rod broke at ultimate load.
68	98	8	½†	1.44	3.0	E	8,120	19,044	19,044	76	Shear.	Shear.	
69	96	6	½†	1.08	2.25	F	5,828	17,724	23,972	73	Tension.	Tension & crush'g.	
70	94	6	½†	1.08	2.25	E	.....	14,992	16,096	76	Shear.	Shear.	
71	78	4	½†	.72	1.5	F	3,126	11,000	16,506	71	Tension.	Shear and tension.	
72	74	4	½†	.72	1.5	E	4,136	9,920	10,980	11	"	Tension.	
73	74	8	½†	1.44	3.0	F	5,020	22,132	29,178	73	"	Tension & crush'g.	
74	96	8	½†	1.44	3.0	E	7,276	17,200	18,584	..	Shear.	Shear.	
75	97	6	½†	1.08	2.25	F	.....	14,476	21,284	75	Tension.	Tension.	One rod broke at ultimate load.
76	97	6	½†	1.08	2.25	E	.....	16,716	17,300	76	Shear.	Shear.	Elastic limit of steel reached at ult. load.
77	98	4	½†	.72	1.5	F	.....	11,224	15,072	71	Tension.	Shear and tension.	
78	98	4	½†	.72	1.5	E	.....	11,424	14,148	11	"	Tension.	

†All steel ½-in. corrugated rods.
‡(Shear cracks, elastic limit of steel or crushing.)
Spans of all beams 60-in., except for beams 65 and 66, which had 40-in. spans.
Beams 1 to 30, inclusive, reinforced with straight rods in tension side (Arrangement A).
Beams 43 to 54, inclusive, reinforced with curved rods in tension side.
Beams 55 to 64, inclusive, reinforced with straight rods in tension side (A—without stirrups; D—with stirrups).
Beams 65 to 78, inclusive, reinforced with equal number of straight rods in tension and compression sides (E—without stirrups; F—with stirrups).

Beam No. 11—Holding a Load of 13,770 Lbs.

Beam No. 60.

Beam No. 15.

Beam No. 61.

Beam No. 16.

Beam No. 64.

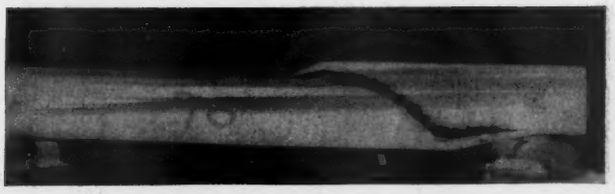
Beam No. 27.

Beam No. 71.

Beam No. 44.

Beam No. 75.

Beam No. 47.

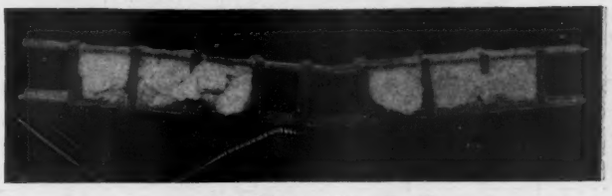


Beam No. 76.

Beam No. 52.

Beam No. 73—Holding a Load of 28,400 Lbs.

Beam No. 57.



Steel Skeleton of Beam No. 73.

Tests of Reinforced Concrete Beams—Boston Transit Commission.

with corrugated (Johnson) or twisted (Ransome) bars and failing in tension were very large before the ultimate load was reached, in some cases being as much as 4 in. (see illustration of beam No. 73). In the beams reinforced with plain bars the margin between the load at the elastic limit of the steel and at ultimate failure was very much less than in the beams having deformed bars. This is to be partly attributed to the difference in the stress strain diagrams of the high and low elastic limit steels.

The first tension cracks in the concrete were quite variable, both as to the loads and deflections at which they occurred and in the rapidity with which they extended up the sides and across the bottoms of the beams, and were influenced somewhat by slight vibrations caused by elevated trains passing in the vicinity. In every case where horizontal shear just above the rods occurred it was only a secondary cause of failure. The diagonal crack due to shearing forces would start about half way between the top and bottom of the beam at the point marked "C" in illustrations of beams Nos. 15 and 16, and would gradually extend toward the center at the top and the nearest support at the bottom until failure occurred. The piece above the rods and outside this crack would then suddenly break away from the rest of the beam. The shape of these cracks corresponds very closely to the theoretical resultant stress lines in the beam.

Beams Nos. 47, 60, 63-66 were accidentally broken, probably while being removed from the moulds. These initial vertical cracks extending through the beams seemed to have no effect whatever on the failure of the beams when tested.

Teaming Yards.*

The local freight business at a terminal may be divided into three classes: 1st, freight received and delivered through freight houses; 2d, freight received and delivered on team tracks, and 3d, industry freight or that received from and delivered direct to factories or warehouses, by means of private tracks. The first and second class have this in common, namely, that for both of them the railroad must supply roadways adjacent to its tracks or freight houses.

On an average 35 per cent. of the local St. Louis freight tonnage belongs to the first two classes, and 65 per cent. belongs to the third class. The freight included in the first two classes might be properly called teaming business, because the transfer of freight between shipper and railroad is effected by means of teams, and the facilities provided by railroads for this business, whether they consist of freight houses, tracks and roadways or only tracks and roadways, may properly be called teaming yards. It is evident that the teaming yard is a decidedly important adjunct to a terminal property, the more so as it is a place where the railroad comes into intimate contact with a large number of its patrons or their employees. If the shipper can load or unload his freight with comfort and economy, the railroad makes friends, and friends of that kind mean increased revenue. If, however, the contrary is the case, only those persons who cannot possibly go elsewhere will use the yard.

A teaming yard in a large terminal, if properly constructed, should have the following characteristics:

1. A track arrangement giving the greatest possible car capacity adjacent to the roadways and substantial track construction. If the ground is so shaped that comparatively short tracks holding not more than 15 cars must be put in, this can best be accomplished by the use of sharp curves and short switches, as these are great economizers of space. Twenty degree curves and in extreme cases 30-deg. curves are not too sharp, and should be used. If it can be avoided the switching should not be done on the main track, as that always involves serious loss of time to the switching crew, and thus impairs the efficiency of the yard. On account of curved tracks and leads there is, of necessity, quite a proportion of the track space that is not suitable for delivery purposes, and it is not necessary therefore, except in very large yards, to provide any special classification tracks, the curved tracks and leads above mentioned being sufficient for this purpose. The delivery tracks should be arranged in pairs and should be not less than 12 ft., center to center; 12½ ft. is better. Between the pairs of tracks space for roadways not less than 36 ft. between track centers should be allowed. Further details of track arrangement depend entirely on the shape of the ground available, each case being a separate problem and having its individual solution. The tracks of the yard should be substantially and carefully built so as to reduce the danger of derailments. While defective track in teaming yards is not as dangerous as in other places on account of the slow speed at which the switching is done, it should nevertheless be avoided, because derailments are always both expensive and result in loss of time.

2. The chief features of a well designed teaming yard are properly graded and paved roadways. They should be at least as well built as the public streets connecting with them. This is very essential but frequently neglected. Those who have observed the conditions of the roadways in the average teaming yard, especially in the winter and early spring, must agree that it is deplorable. The stalling of teams is a matter of almost hourly occurrence in wet weather. Instead of governing the loading of wagons by the amount the team can haul over the streets, a half load is often more than can be pulled through the mire in the teaming yard. As a result of such conditions, loss of time is inevitable in loading or unloading freight from cars, and this loss in turn reduces the capacity of the yard, often to a serious extent. The shippers are dissatisfied on account of the delays and extra expense to which they are put, the poor roadway frequently doubling the teaming cost, already a large item of expense.

Where the yard is reached by paved city streets, the roadways should also be paved. A thoroughly satisfactory roadway of vitrified brick can be built at a comparatively small cost in the following manner: After the tracks have been laid the roadway should be excavated to a depth of 12 in. below the surface of the finished pavement, and thoroughly compacted with a heavy horse or steam roller. Care should be taken to remove all soft or spongy ground in the foundation and replace the same with any suitable dry material. If possible, the roadbed should be built on a grade, so as to be self-draining, great care being taken to leave no pockets that will hold water. Water is the greatest enemy to a good pavement as it is to a good track. After the roadbed has been treated as above described, a foundation course of macadam is spread to a depth of about 6 in. and thoroughly rolled with a heavy steam roller. This macadam after rolling becomes so dense and compact that a wagon driven over it leaves no noticeable mark. On the macadam foundation is spread a layer of sand, which is washed into the interstices between the stones of the foundation, and the operation is repeated until they are all filled. The object of washing the sand between the stones is to prevent the sand cushion to be placed upon the foundation from slipping into it, thus causing a settlement of the pavement proper. Upon the prepared foundation is spread a sand cushion about 1½ in. thick, upon which is laid the vitrified brick pavement. The brick should be set on edge, and should be paved close together in straight rows, and should conform accurately to the surface of the pavement. After this is done the pavement is again rolled and the bricks brought to an even surface. Hot, dry sand is then spread upon the pavement, and swept into the joints until they are filled; after which the pavement is ready for use. In order to protect the edges of the pavement a curb made of oak crossing planks set on edge is used next to the tracks.

A pavement such as is here described, will be found fully as serviceable as more expensive pavements, just as cheap to maintain and just as satisfactory to shippers. In fact, the maintenance for several years will be almost nominal. It will cost, according to present prices of materials, assuming that all of them can be delivered on cars and that the excavated material can be removed on cars, not to exceed $1.40 per square yard, or to put it in another way, the roadway space in front of a 40-ft. car will cost about $80, or only about one twentieth of the value of the ground upon which it is placed.

With a roadway, such as described above, a team can haul fully twice the load that it can drag over an unpaved roadway. Stalling of teams will be entirely eliminated, the capacity of the roadway will be more than doubled, because its capacity is measured not by the number of tons hauled over it, but by the number of teams doing the hauling, and the rapidity with which they can do their work. This in turn brings about a more rapid loading or unloading of cars, materially reducing the car detention, which determines the working capacity of the yard.

As an illustration of the value to a railroad of a good pavement in a teaming yard, the following report of business done in a certain yard during a few days in November, 1903, and the corresponding period in November, 1904, is submitted. In 1903 the roadways were unpaved, and since then a vitrified brick pavement has been laid. In the earlier period 56 cars were unloaded and the average detention per car was 56 hours. This year 110 cars were unloaded in the same length of time, the average detention per car being 53½ hours, or practically double the amount of business with a decrease of 2½ hours per car, or 4½ per cent. in car detention. As there was no change in the track arrangement of the yard, and as the general business of the line in question was as heavy in 1903 as in 1904, it clearly indicates that the results shown are due to the appreciation by shippers of the value of good roadways, and that the company providing them, other things being equal, will get the business.

Another illustration is the contrast in the condition of two teaming yards in East St. Louis belonging to the same company, both of which are equally accessible. One has a good paved roadway, the other has not. The average detention per car by consignee for several days in November, 1904, was 49.2 hours in the paved yard and 57.6 hours in the unpaved yard, a difference in favor of the paved yard of 8.4 hours, or 14.6 per cent. The superintendent of the road says that their paved yard is always crowded to its full capacity, while it is almost impossible to get shippers to receive their freight in the unpaved one; in fact, shippers anxious to receive their freight have been known to

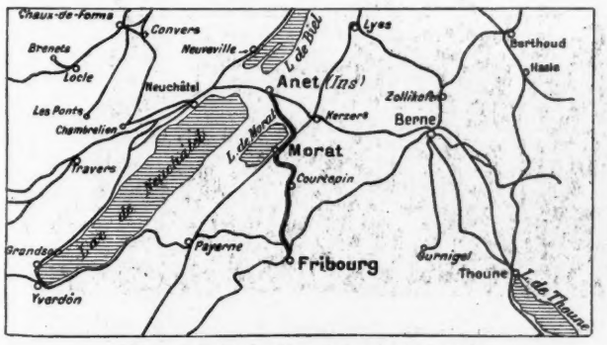
*Extracts from a paper by H. J. Pfeifer, Gen. Supt. of Construction, Street Department, St. Louis, read at the December meeting of the St. Louis Railroad Club.

wait several days for a place for their car in the paved yard, rather than go to the unpaved one where immediate delivery awaited them.

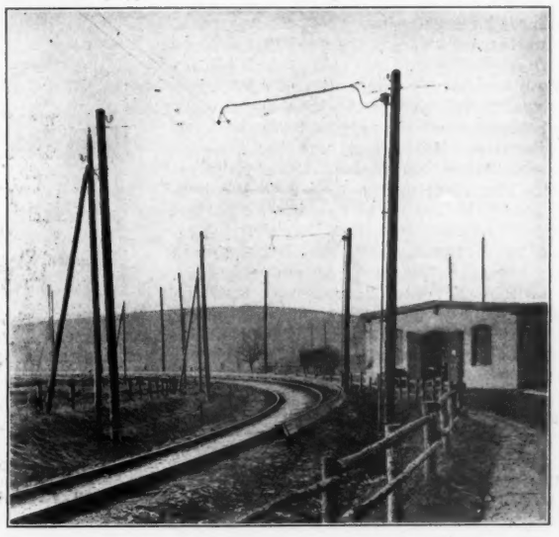
The Friburg-Morat-Anet Electric Railroad.

BY L. DE BEUL.

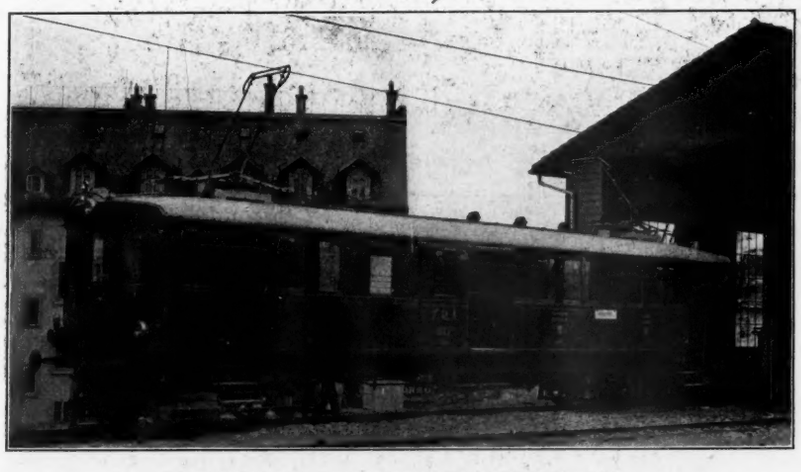
A short engineering description of the Friburg-Morat-Anet Railroad, in Switzerland, was printed in the *Railroad Gazette* April 8, 1904. The following account amplifies this somewhat, and also deals with the traffic results following electrification of part of the line. That portion of the road between Friburg and Morat, approximately 15 miles long, which completes the connection between the two main lines, Olten-Berne-Lausanne and Olten-Soleure-Lausanne is not new but has been operated for some time with steam locomotives by the Jura-Simplon Railroad for the account of the Friburg-Morat Railroad Company. The electrification of this stretch of line, including the installation of new equipment, had to be accomplished while the traffic was going on. The section between Morat and Anet, seven miles long, has just been completed, and it is proposed to connect this with the direct line from Berne to Neuchatel. Electric traction was decided upon as a means of reducing the running expenses which, by reason of the excessive grades, were very heavy under steam.



Map of Friburg-Morat-Anet Railroad.



Overhead Wires at Stations; Third Rail Outside.



Motor Car, Friburg-Morat-Anet Railroad.

The profile of the line is very undulating. The difference of level between Friburg and Anet is only 635 ft., but the grade from Anet to Friburg is not continuous and the profile has sharp ascents and descents. The maximum grade is 2 per cent. and extends over a stretch of 2⅓ miles. Power is taken from a third rail. This power is generated in a central station at Friburg as three-phase current at a tension of 8,000 volts; it is afterward converted at the substations into a continuous current of 750 volts and applied through series-wound motors in the motor cars. This system is preferred for many reasons. It permits of the use, in the substations, of storage batteries that effectively regulate the load at the generating station. Under these conditions the electric energy needed for the service of the railroad is obtained at a greatly reduced cost. The batteries in the sub-stations moreover offer a reserve in case of any momentary derangement of the primary line.

A third rail weighing 50 lbs. per yard has been adopted, and carries a current of high intensity better than copper feed wires do, particularly when heavy trains are run. As a safeguard against accidents the live rail has been provided with a covering or running board which leaves only sufficient space between it and the rail for the easy entrance and passage of the contact shoe. In the stations a more elaborate covering has been put in. In order to avoid any serious modifications in the terminals already existing at Friburg and Morat and belonging to other railroads, there has been provided in these and in several of the intermediate stations a system of overhead conductors delivering their power to the sliding bow upon the top of the car. The third rail is, of course, discontinued in these terminals. At several of the intermediate stations where the line is laid with a single track and a siding, the third rail is continued only on the side opposite to the station, while the overhead wire is stretched above the road running into the station.

The trains are made up of a double truck passenger coach with motors and a certain number of trailers, which carry either passengers or freight. The weight of the train is fixed at a maximum of 70 tons, and the normal train consists of an eight-wheel motor coach, a six-wheel trailer, and three four-wheel trailers. The speed upon the steepest grades is about 14 miles an hour, increasing to a maximum of about 28 miles an hour on the down grades. The motor coaches have a second class compartment with eight seats, a third class compartment with 20 seats, for smokers, and two other third class compartments of equal seating capacity for non-smokers. Between the second and third class compartment is a small baggage room. Both ends of the motor coach are enclosed in glass, and the motor man's cab is set in front of the platforms used for the entrance and exit of passengers.

The line from Friburg to Morat was opened for business on Jan. 1, 1903. Many obstacles arose during the first months which demoralized any regular schedule, but these have been successfully met. On July 23 the continuation of the road from Morat to Anet was opened for traffic by electric traction so that except in cases of a great rush of passengers or a congestion of freight the locomotives were practically abandoned. The most serious operating problem at the present time is the removal of snow, and especially of ice, from the contact rail. Many attempts at this were made last winter with varying success.

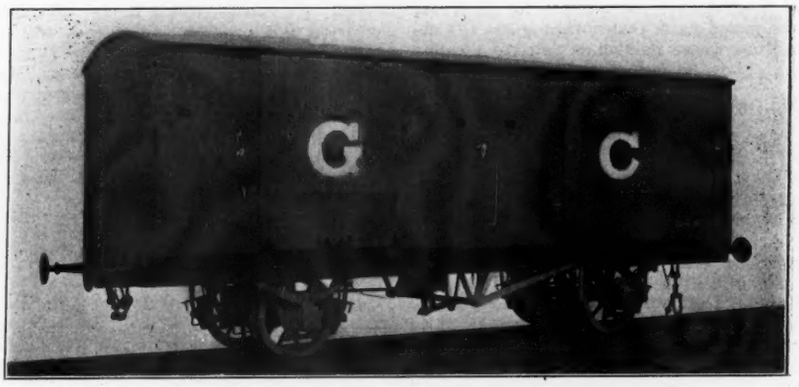
From January 1 to April 30 a schedule was put into operation calling for 14 regular trains a day, seven in each direction. During the summer season these were increased to 16 trains. The following table shows that the growth of new business attendant upon the inauguration of an electric service is not confined to American practice.

	No. passengers carried.		
Month.	1901.	1902.	1903.
January	6,290	6,226	8,704
February	5,816	5,788	7,301
March	6,270	6,788	9,089
April	7,961	7,419	7,937
May	8,237	7,251	18,575
June	9,464	7,502	17,192
July	10,313	9,187	19,280
August	10,111	10,459	21,254
September	10,845	10,505	24,477
October	9,738	7,797	19,057
November	6,957	6,562	19,634
December	6,416	5,906	13,277
Total	98,418	91,380	186,095

Freight traffic also has increased notably

since 1898, and particularly in 1903, but in this case the competition of even longer roads is, of course, felt much more than it is with passenger traffic, where quick time and a convenient service are as important considerations as a low rate of fare. Considerable delays ensue before the effect of a shorter route and the creation of new commercial relations make themselves felt by an increase in freight traffic; not until the new tariffs together with other preliminary measures have gone into effect can any exact accounting be made of the freight traffic of the line.

Upon several occasions the company has been compelled to consider the question of the repartition of the freight traffic between its own line, Morat-Anet, and the lines of the competing companies, Morat-Chiétres-Anet. The consultations held with the Federal roads and the Berne-Neuchâtel Railroad Company had not furnished any positive results up to the end of 1903, but there is every reason to hope that an amicable solution will result; one that will give the company, at least in part, the traffic to which it considers itself entitled by reason of its direct route.



15-Ton Covered Goods Wagon, Great Central.

20-Ton Hopper Coal Car, Great Central.

High Capacity Cars on the Great Central of England.

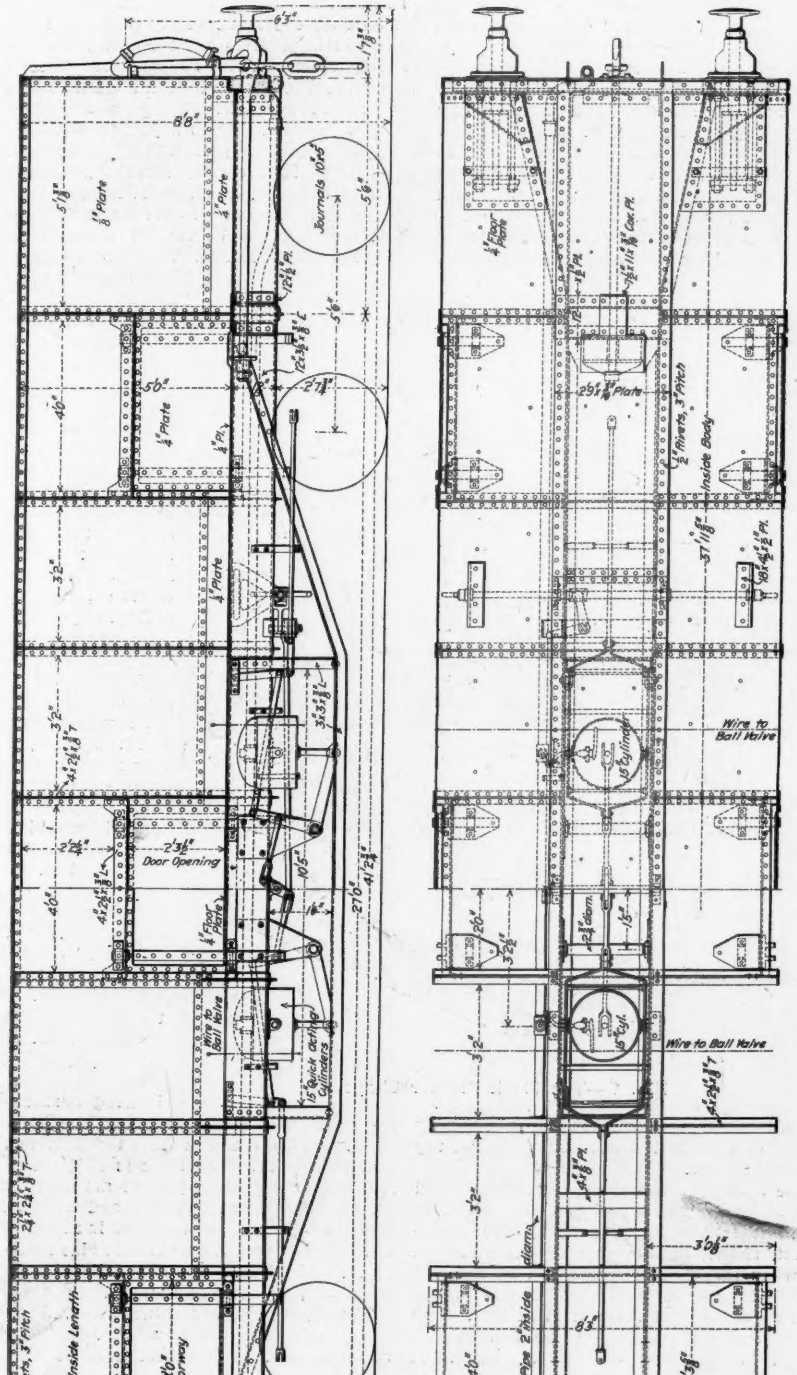
The Great Central Railway has a direct line across England from Manchester to Sheffield, Hull and Grimsby with branches to Liverpool and North Wales and a line to Nottingham, Leicester and London. It does a large freight business—the receipts last year being £2,190,592 with a freight train mileage of 7,661,333—and it was one of the first roads in England to experiment with high capacity cars. Some time ago a number of 30-ton steel gondolas were put into

40-Ton Steel Coal Car Built for the Great Central of England.

service and about the same time a new design of steel underframe fish car was introduced to be used in the fish traffic between Hull and Grimsby and London. The steel gondolas are being used for coal and are 37 ft. 11¾ in. long, 7 ft. 6¾ in. high and 4 ft. 2 in. deep, inside measurements. They have a light weight of 30,913 lbs., and are mounted on diamond arch-bar trucks. The fish cars are 44 ft. 4 in. long inside and have a capacity of 15 tons with a tare weight of 42,675 lbs. The bodies of these cars are wood with ventilated slat sides and ends. They are run in solid trains out of Grimsby and are a unique type of rolling stock for special service.

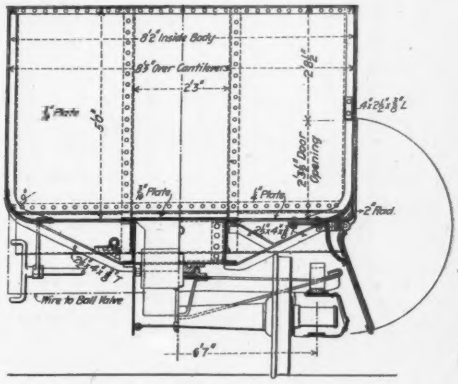
So successful have been the results of the working with these cars that orders were recently placed for 100 more of the fish cars, 150 large covered cars for general service,

20-Ton Steel Coal Car, Great Central.



Side Elevation and Half Plans of 40-Ton Coal Car for the Great Central of England.

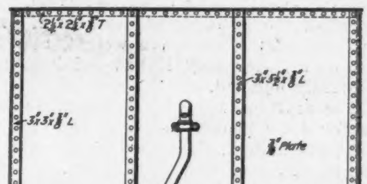
and 150 steel coal cars of 20 tons capacity. The covered freight cars will replace a similar number of small four-wheel low-side cars which have been used for pig iron and for carrying merchandise. One of them is shown in one of the accompanying illustrations. These cars were built by the Metropolitan Amalgamated Railway Carriage & Wagon Company at Ashbury, England. They are 26 ft. 5 in. long, 7 ft. 3 in. wide, and 7 ft. 1½ in. high, inside measurements, and have a cubic capacity of 1,425 cu. ft. The marked capacity is 15 tons and the tare weight is 23,000 lbs. On each side of the car there are two door openings 5 ft. wide, closed with double sliding doors. An opening through the roof, the width of the doorway, is closed with a sliding top door which



Cross-Section of 40-Ton Steel Coal Car.

may be removed to permit the car to be unloaded with a crane. The underframe is composed of steel channels and rests directly on the journal boxes through half-elliptic springs placed outside the pedestals. Either-side hand brakes and vacuum brakes are applied and the cars are fitted with screw couplings.

The 20-ton, self-discharging steel coal cars ordered were built by the Leeds Forge Company. These cars, which have replaced a number of small 9-ton cars formerly used, have a tare weight of 18,600 lbs. and a cubic capacity of 800 cu. ft., giving them an increase in carrying capacity of 122 per cent. with an increase in tare weight of only 48 per cent. over the small cars. They are 22 ft. long and 8 ft. 3 in. wide, and have a



End Elevation of 40-Ton Steel Coal Car.

wheel base of 12 ft. The floor slopes to a central hopper which has a double drop door opened and closed with a self-locking mechanism which may be operated from either side by turning the lever on the end of the central shaft half a turn. A screw hand brake which may be operated from

either side is applied at one end. This type of car can be used on almost any of the coal trestles or docks along the company's lines and is giving very satisfactory results in service.

The 20-ton, flat-bottom, steel coal cars also shown in one of the illustrations have the same cubic capacity as the self-discharging cars before mentioned, and will carry the same load, but the tare weight is only 17,000 lbs. They have two small doors in each side near the floor for unloading and are fitted with hand brakes and piping for vacuum brakes. These cars are intended for carrying coal for the company's locomotives only and like the hopper cars were built by the Leeds Forge Company.

The most interesting type of cars among the new equipment ordered is the 40-ton steel gondola shown. A number of these cars are now being delivered by the Birmingham Railway Carriage & Wagon Company, Smethwick, England. In some respects these cars are the largest ever used in England. They are 37 ft. 11⅝ in. long, 8 ft. 2 in. wide and 5 ft. deep, inside measurements, and are used in hauling coal for the company's locomotives. The accompanying drawings, which are reproduced through the courtesy of Mr. J. G. Robinson, Chief Mechanical Engineer of the Great Central, show the details of construction, which differ in some important respects from the usual practice in this country.

The underframe is of the Livesey-Gould type consisting of two longitudinal trussed sills forming the back-bone, as it were, and carrying all of the load. Eight T-iron cross-bearers, 4 in. x 2½ in. x ⅜ in., are riveted to the center sills on the under side and are bent up at the ends and riveted to the T-iron side stiffeners at each panel point. There is no bolster and the sides are not depended upon to carry any portion of the load as girders. The center sills are 3½-in. x 12-in. x ⅜-in. channels weighing about 25 lbs. per foot, spaced 22 in. apart with flanges out. Each sill is trussed with a 3-in. x 3-in. x ⅜-in. angle attached to the web of the channel just behind the center plate. The queen posts are angles bent in the shape of a rectangle and attached to the sills 5 ft. 2½ in. each side of the center of the car. They have a drop of 16 in. and are riveted to the truss rods. This practice of trussing steel sills is one which is fairly common abroad but which has been used only to a limited extent in this country in the designs of Mr. George I. King, of the Middletown Car Works. It is an effective method of increasing the stiffness of the central girder without adding excessive weight, and it is not quite clear why it has not been more generally adopted.

The draft gear on these cars is the usual center draw hook type with coupling chain and side buffers. The draw hook stem is 2 in. in diameter and extends back between the center sills to the combination spring coil and rubber draw spring placed behind the double filling block which serves as a bolster. A 12-in. channel is used for the end sill, and this is supported at the outer ends by diagonal braces of 3½-in. x 9-in. x ½-in. bulb angles extending back to the center sills. The buffer springs are carried on brackets attached to the under side of the floor and to the diagonal braces.

These cars have three unloading doors in each side near the floor. The door opening is 4 ft. wide by 2 ft. 3½ in. high, and the doors swing out and down, being hinged at the bottom. They are held shut by a simple latch at the top. Vacuum brakes and either-side screw hand-brakes are applied and the cars are mounted on diamond arch bar trucks with 5-in. x 10-in. journals. The tare weight is 33,544 lbs.

Railroad Shop Tools.

(Continued.)

SHAPERS.

The accompanying illustration, Fig. 1, shows a shaper made by The Mark Flather Planer Company, Nashua, N. H. A uniform speed and a quick return are imparted to the ram of this machine by a combination of the Whitworth quick return and the slotted lever crank movement. A graduated collar shows the length of stroke that is being used and the ram can be brought to any position

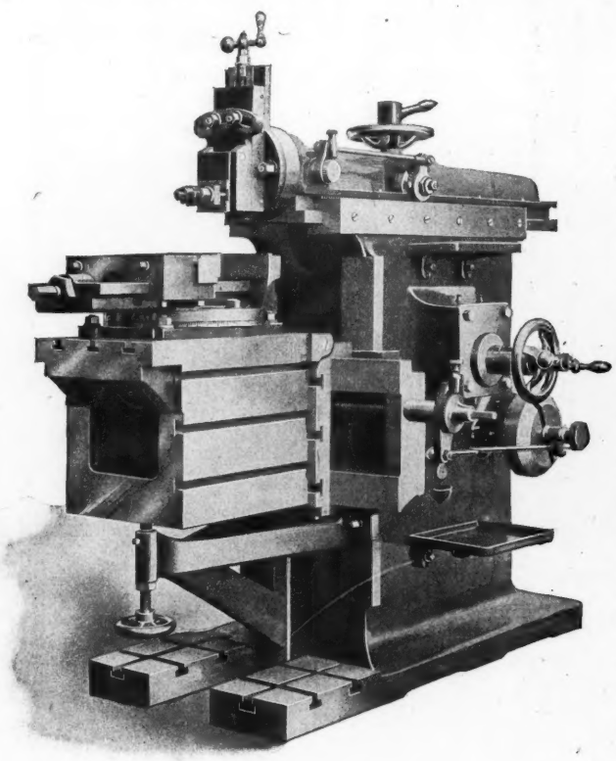


Fig. 1—The Mark Flather Shaper.

desired while the machine is running by means of the hand wheel shown on the top of the machine.

The crank pin is adjusted by a scroll and two racks so that it is impossible for it to slip, either when tightened by the hand-wheel, shown on the side of the machine, or when loose. The stroke can be changed to any length while the machine is in motion as readily as when it is at rest. The angle-piece for supporting the box-table is bolted to the lower edge of cross-rail. It has an adjustable bearing on the outer edge of box-table and the lower end bears on a rib cast on the front of lower part of column which projects as a bearing for the raising screw. This support is directly under the cutting tool at all times, being raised and lowered with the cross-rail, which makes it unnecessary to adjust it whenever the position of the cross-rail is changed. The pitman is directly pivoted to the slide-block in the ram, and the lower end slides on a shoe that has a pivotal motion on the shaft through the center of the column. This motion increases the uniformity of the cutting speed and allows the pitman to be shaped at its upper end so that a long shaft can be run through the center of the column for key-seating or other work. The large gear is placed very near to the under-side of ram, thus reducing to a minimum the tendency of the pitman to spring. Sixteen changes of speed are provided. The back gears are contained inside the driving cone pulley and the drive can be quickly changed from open belt to back gears. The tool will machine a piece of work 24 in. long by 26 in. wide by 16½ in. high. The vise jaws are 14 in. long by 2⅝ in. wide and have a maximum opening of 13¼ in. The tool has a down feed of 7 in. and the ram is 10⅞ in. wide and has a bearing surface 36 in long. The total length of the ram is 59 in. and the distance from the floor to the ram is 46½ in. The table is 15½ in. x 22 in. The countershaft pulleys are 14 in. x 4 in. and should run at 100 and 200 r.p.m. The net weight of the machine is about 4,800 lbs. This design of machine is also made in 14 in. and 18 in. sizes.

TRAVERSE SHAPERS.

The accompanying illustration, Fig. 2, shows the front view of a 26-in. double traveling head shaping machine made by the

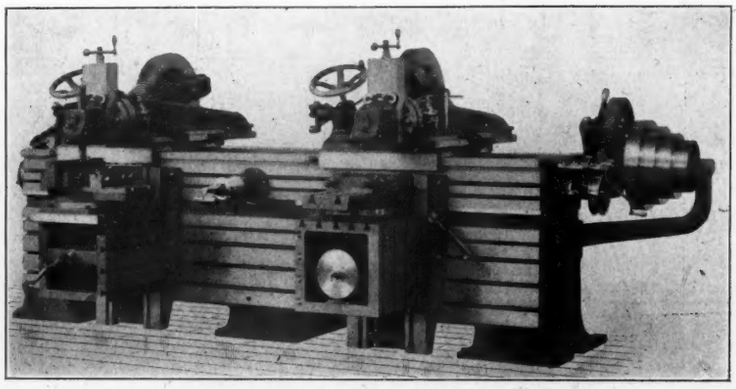


Fig. 2—Niles-Bement-Pond Double Traveling Head Shaper.

Bement, Miles Works of the Niles-Bement-Pond Company, New York. A number of these machines have been installed in railroad shops, for which work they are particularly adapted. The maximum stroke of the machine is 26 in., the vertical adjustment of the tool is 8 in. and the length of the bed is 14 ft. Two tables are furnished with the machine; one has a vertical and a horizontal clamping surface and the other has a horizontal clamping surface only. Both tables are adjustable horizontally on the bed by rack and pinion and vertically by means of a screw in front of the machine. The saddles have variable power feeds along the bed in either direction and rapid hand movement by rack and pinion. The cutter bars have Whitworth quick return and adjustment for any length or position of stroke. The tool slides swivel, and when

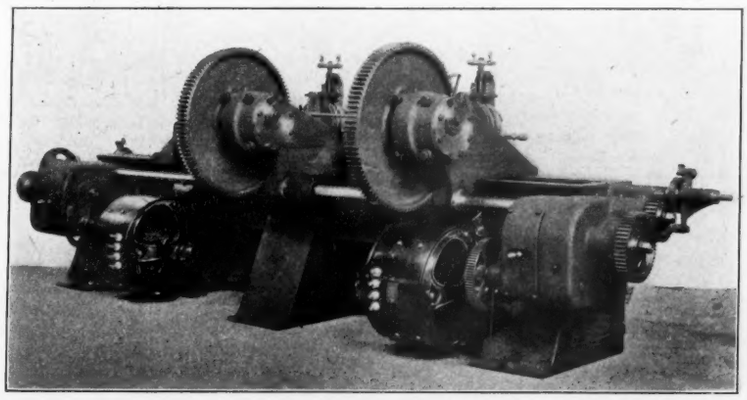


Fig. 3—Niles-Bement-Pond Double Traveling Head Shaper, Showing Method of Attaching Motors.

desired are provided with power feed. This type of machine is built in four sizes ranging from 12 in. to 26 in. stroke.

Fig. 3 shows a compact method of fitting this machine with motors and gear speed boxes. The motors are 7½ h.p. each, having a speed range by means of field control from 100 to 1,400 r.p.m., and with the speed changes by gearing obtainable through the speed boxes the machine will give from 4 to 40 strokes per minute. This machine is furnished with a swivel vise, index centers and a cone arbor. These are shown in the foreground of Fig. 2. The cone arbor has a power rotary feed in either direction.

Fig. 4 shows a 24-in. double-head pull cut traverse shaper made by the Cincinnati Shaper Company, Cincinnati, Ohio.

The difference between this and the ordinary type of traverse shaper is that the cutting tools are reversed, the cutting taking place during the backward motion of the ram and quick return during the forward, the operation being directly opposite to that in the usual form of shaper.

The advantage of this design is that the pressure or thrust of the tool is taken directly back against the bed of the machine, and tends to draw the table and apron more closely to the bed, rather than force them apart. This is of a decided advantage, especially when heavy cutting is being done, as is the case since the introduction of high speed steels. Then, in many cases, the work itself can be pressed directly against the bed of the machine, so that the resistance to the cutting is not altogether dependent upon the hard clamping of the work and the table. The tables of this machine can be removed and large pieces can be directly bolted to the bed.

The head is constructed so that the stress due to the cut comes directly upon solid metal contacts, and not upon threads, bolts or screw points, except in the case of the set screws for holding the tool. These screws are large in diameter, and have a long bearing. Except for the head and ram and some other minor modifications this traverse shaper is similar to the ordinary push cut machine made by the same company. The bed of this tool is 144 in. long, 26 in. wide and 36 in. deep, and is provided with T slots, as shown. The saddles carrying the rams are provided with taper gibs for taking up wear, and each saddle is operated by a full length separate screw; thus the rams can be operated independently of one another when placed in any position on the bed. The saddles have a 30 in. bearing on the bed and each saddle has a traverse of 80 in. along the bed by means of a pulley and belt attached to the end of the screws. The minimum and maximum distance between the tools is 33 in. and 113 in. respectively. Each head is provided with variable automatic down feed of 8 in. Micrometer collars reading to .001 in. are placed on the down feed screws in the heads as well as on the traverse screws operating the saddles. The heads are also provided with a worm for circular work. The greatest distance from the table to the ram is 22½ in. Both tables are vertically adjustable on the apron and horizontally with it along the bed. One of the tables is plain and the other graduated and is arranged to swivel through an arc of 90 deg. by means of a worm and worm wheels. The top of the plain table is 24 in. x 20 in., and the top of the revolving table is 20 in. x 20 in. A circular mandrel is furnished with the machine; this is connected to the saddle as shown, and the circular feed can be had either by hand or power. On removing the mandrel an opening four inches in diameter is obtained through the bed through which shafting, etc., may be passed for keyseating or similar work. The gearing is of wide face and large diameter and the machine being back geared has, with the four step cone pulleys, eight cutting speeds to the ram, which is ample for working in all classes of metals.

(To be continued.)

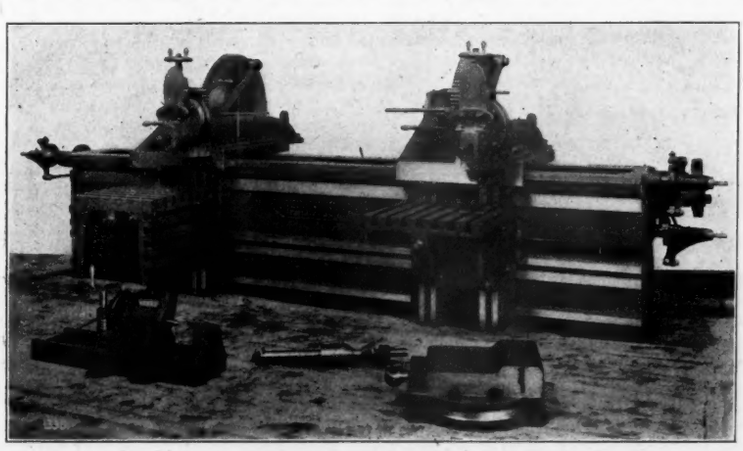


Fig. 4—The Cincinnati Double Traveling Head Shaper, with Pull Cut Head.

Census Bureau Report on Telephones and Telegraphs.

The Census Bureau has just published the fourth of a series of reports on the generation and utilization of electric current in the United States, up to and including 1902. The three preceding reports dealt with street and electric railways, electric light and power plants and municipal electric fire-alarm and police-patrol systems. The present bulletin is about telephones and telegraphs. All of these reports were prepared under the direction of Mr. W. M. Steuart, chief statistician for manufactures.

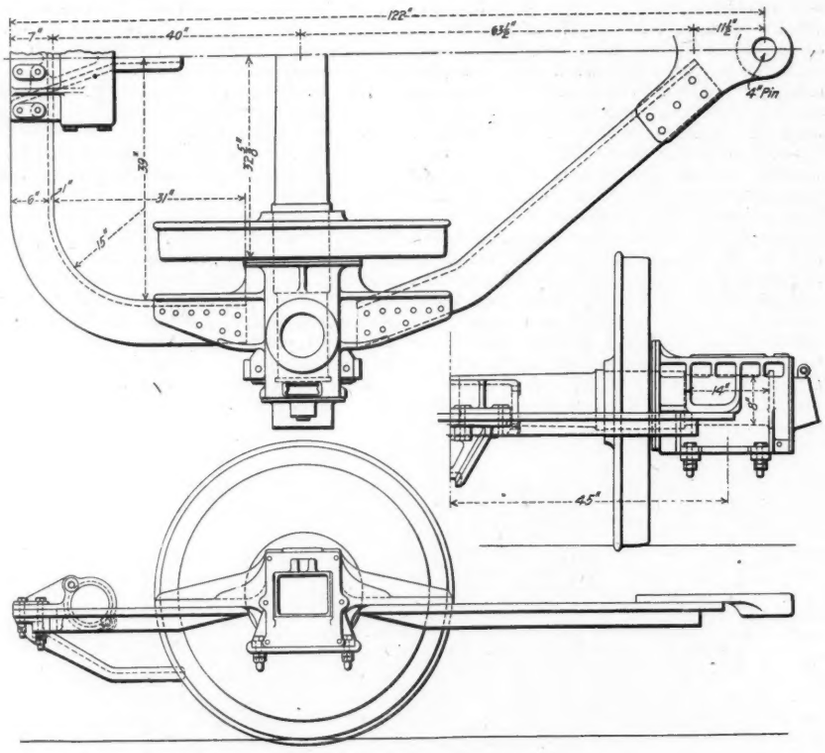
The report shows that at the census of 1880, the telephone industry was in embryo, few commercial companies being in operation prior to that year. In 1880 the population of the United States was 50,155,783, and the number of telephones of all kinds was 54,319, an average of 923 persons per telephone. The population of the United States (excluding insular possessions) in 1902 was estimated at 78,536,436, and the number of telephones operated in that year was 2,315,297; an average of 34 persons per telephone. The number of miles of wire in use in 1902 was 141 times as great, and the number of telephones 43 times as great, as in 1880. The number of miles of wire and the number of instruments operated in 1902 by the independent rural lines, which in 1880 were not in existence, were in excess of the totals for the entire industry in the earlier year. The total revenue of all telephone systems from operation and all other sources amounted to $86,825,536, or an average of $37.50 per telephone. Of this amount, 94 per cent. was derived from actual operation. The total operating expenses amounted to $56,867,062, or $24.50 per telephone; the total net income was $21,660,765, or $9.36 per telephone, and the net surplus for the year was $6,678,046, or $2.88 per telephone. The commercial and mutual systems reported 2,315,297 telephones in operation during 1902. Of these, 10,361 were public exchanges, 80,870 were public or semi-public stations used by the general public upon the payment of a fee, and 2,244,066 were private telephones. There were 2,178,366 subscribers reported, giving an average of approximately one telephone to each subscriber. The estimated number of messages during the year over

the wires of the commercial and mutual systems was 5,070,554,553. For the 4,985 rural lines, no estimates could be obtained. Of the total number of messages reported, 97.6 per cent. were local and the remaining 2.4 were long distance and toll. The strong tendency toward concentration in the telephone business is shown by the fact that although only 4.7 per cent. of the total number of commercial and mutual systems operated 1,000 telephones or over, this 4.7 per cent. reported 72.5 per cent. of the telephones, 87.5 per cent. of the gross receipts from operation, 89.3 per cent. of the operating expenses and 57.5 per cent. of the net surplus.

The commercial telegraph systems numbered 25 in 1902, as compared with 77 in 1880. The magnitude of the equipment and business has, however, shown a great increase. At the present time, the telegraph business is practically controlled by two companies, yet the number of miles of wire in operation in 1902 was more than four times, the number of messages almost three times and the receipts from messages more than twice as great as in 1880. The average rate per message in 1902, excluding cable messages, was 31 cents, as compared with 43 cents in 1880. The total receipts of the commercial telegraph companies for 1902 amounted to $40,930,038, of which 86.2 per cent. represented the gross receipts from operation. The operating expenses amounted to $26,592,411, the net income to $9,981,004, and the net surplus for the year to $3,725,311. The commercial telegraph companies reported 1,318,350 miles of wire in operation in 1902. The commercial telegraph messages sent during 1902 numbered 91,651,287, and of these, 820,498 were cable messages. There were 684 railroad companies that reported the operation of telegraph and telephone lines. Along their rights of way, these companies had 1,127,186 miles of single telegraph and telephone wire, of which they owned 21.5 per cent. The commercial telegraph messages sent during 1902 numbered 90,834,789, or less than one fifty-sixth of the telephone messages, and the pieces of first class mail matter that passed through the mails during the same year numbered 4,611,271,580, or not quite as many as the telephone messages.

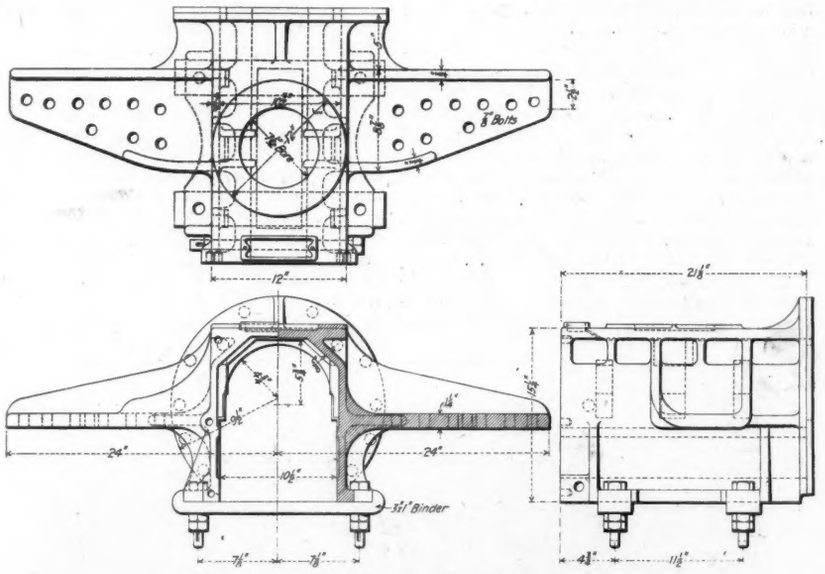
Cole's Radial Locomotive Trailing Truck.

Patents were recently granted to Mr. F. J. Cole, Mechanical Engineer of the American Locomotive Company, for a radial locomotive trailing truck with outside bearings which is shown in the accompanying drawings. This design of truck has been used on the Cole four-cylinder, balanced compound, Atlantic type locomotive built for the New York Central, on the electric locomotives built for the same road and on a number of other engines built during the last year by the American Locomotive Company. It is essentially different from either the Player radial trailing truck with inside bearings or the Rushton truck used on many engines built by the Baldwin Locomotive Works. The Player truck, it will be remembered, has a continuous axle box with journal boxes at each end. To the lower side of the continuous axle box is attached a spring housing fitted with transverse coil springs and suitable followers. Horizontal thrust rods with ball and socket connections at the ends extend out from the spring housing to the pedestal tie bars. This combination of spring and thrust rods permits the truck to travel in a circular path and also permits the continuous axle box to rise and fall relatively to the frames. The lateral motion of the truck is limited by stops in the central spring casing, and when the engine is running on a tangent the springs tend to bring the truck back to its proper central position. The load carried by the trailing truck is transmitted to the continuous axle box through a cradle on which the equalizers and springs bear. Hardened steel sliding plates are interposed immediately over the journals and the cradle is guided vertically by guides attached to the engine frames. The Rushton truck has outside bearings with hardened steel plates over the journal boxes which are concaved on the top surface. Two rollers are interposed between the bearing plates and top bearing plates on which the equalizer springs rest. The lateral motion of the axle is limited by the pedestals and the side movement is resisted by the action of the rollers in lifting the weight of the engine when displaced sideways from their central position. On a tangent the rollers tend to resume their normal central position and return the wheels and axle to their proper alinement with the frame.



Plan and Elevations of Assembled Truck.

The Cole truck combines the essential features of both of these types with an entirely different arrangement. The journal boxes are rigidly attached to the back ends of a V-shaped radius bar which is pivoted at its front end or apex by a pin in a cross brace inserted between the engine frames. At the rear the journal boxes are connected by a U-bar which has a spring housing mounted at the center, containing springs, followers, etc. This spring arrangement is connected with a cross brace between the frames and performs the same functions as in the case of the Player truck with inside bearings. The V-shaped radius bar and the U-bar are made of angle section, 7 in. x 3½ in. x 1 in. In applying the truck, the engine frames are extended back from the rear driver pedestal with two slabs, one inside of the truck wheel



Detail of Journal Box for Radial Trailing Truck.

and one outside of the wheel to which the pedestal jaw is riveted. The equalizer spring is outside of the frame slab and rests on a hardened steel bearing plate. This plate on its under side is formed with two broad shallow grooves having inclined sides and a similar plate rests on top of the journal box. Hardened steel rollers are placed between the two, and when the truck is displaced laterally on a curve the mutual action of these rollers and inclined planes is to furnish a yielding resistance to the displacement in addition to the spring resistance on the U-bar and to constantly tend to restore the truck to its normal or central position.

Picked Up on the Road.

BY GULF.

Artistic lighting is much admired, but the average man is concerned primarily with the practical question of its illuminating power. For that reason one hears no end of complaint about bad station lighting from those who are obliged to spend time in such places waiting for a train. As a glaring example of illumination which is none too glaring, take the Grand Central Station in New York. In the main waiting room there are more than seven hundred incandescent lamps, yet they are placed so high up on the wall, or ceiling, or so effectually toned down by opal or ground glass shades that even when sitting at the end of a settee directly beneath the stand containing a dozen lamps, it is a strain upon the eye to attempt to read coarse print. The effect, however, is good. Perhaps we should be content with effect and let comfort go. But somehow that isn't natural.

Old Homer sometimes nods and so, also, apparently does the most astute of passenger agents. A time-table recently distributed from one of the larger offices of a great trunk line bears no date. There is nothing to indicate whether it went into effect in 1894 or 1904. It is about on a par with the performance at another large station of the same line, that only contained one time-table of trains and that was in the depot master's office, who refused to let a passenger look at it on the grounds that it was for the "information of employees only."

The excerpt from the *Wall Street Journal* reprinted in the issue of October 21, on Railroad Graft, sets one to thinking whether or no this feature of railroad depletion is not responsible for much of the inertness of railroad officials to adopt well-known and tried methods of reducing operating expenses. So long as an official is not "jacked up," for not getting better results he is apt, in the hurry of pressing matters to forget the "minor matters of the law," so long as there is nothing in it for him, and the widely acknowledged means of introducing new appliances is that of "interesting" railroad officers. This brings one naturally to the advocacy of a "recommending" engineer whose duty it should be to visit shops and other places and persistently recommend improvements that will pay. This, in turn, recalls an experience of an engineer who, after visiting the principal shop of a large road, offered to run it on shares; that is, take for a salary one-half of what he would save from the current expense, incidentally remarking that he thought it would net him from 10 to 12 thousand dollars a year.

Apropos of the discussion on despatching discipline, train registers, etc., that has recently occupied much attention, here is an example from practice. A train due to arrive at a terminal at 10.50 was 35 minutes late, and the same engine was marked up to take out a train at 11.55. On arrival, both the conductor and engineer, men who had evidently grown up in the service and had passed the middle line, registered the arrival and at the same time that of the departure on the return trip, but put the leaving time down as 11.56, one minute late. Both then went off about their business and paid no more attention to the register. As a matter of fact the train left at 12.17, or 21 minutes after the recorded time. To the layman the questions naturally arise as to what earthly use a register kept under such conditions can serve; as to how many train registers would bear close scrutiny as to their accuracy, and of what value they would have in court even though supported by the oath of men, if such irregularities were to be known. Is it due to slackness of discipline, to disregard of minute detail on the part of the men, or to the impossibility of hiring reliable employees?

The use of clips on the window post for holding ticket checks, which is thought to have originated on the Chicago, Milwaukee & St. Paul, is extending. It is convenient for the conductor, who knows exactly where to look for the check, and convenient for the passenger, as it avoids the necessity of keeping the check in sight; a convenience that is especially appreciated by women, and it must save the time of a conductor in working a long train with frequent stops. If the companies that have adopted it would supplement their action by putting in generous parcel racks like those of the New Haven road instead of trying to satisfy the public with card baskets, comfort would be still further enhanced.

It is interesting to note the rapid growth in the use of snow fences during the past few years. Ten years ago, after the European railroads had spent a long time in the development of the snow fence and had definitely adopted certain forms suited to special conditions, there was hardly an example in use in this country east of the Rockies. Our engineers had evidently not learned the value of that wonderful ounce of prevention. Even now that the snow fence has become a common object in the winter landscape along our railroads it does not vary in form to the same extent that it does abroad. The standing shape that it seems to have taken here is that of an open fence of horizontal rails sloping toward the track at an angle of about 45 deg. to a height of about 5 ft. and then cutting back at the same angle for 18 in. or 2 ft. more. The curious thing about it is that we should have been so much behind our friends across the water in the adoption of this most valuable and labor-saving device. The effectiveness of this method of protecting has been so thoroughly well proven that it is suggested that it might be well to hold the chief engineer responsible for snow blockades.

Court Decisions on Traffic Questions.*

Interstate Transportation.—An interesting question arose in the United States Supreme Court, in Pennsylvania Railroad Company vs. Knight (192 U. S., 21), as to whether a cab service maintained by the Pennsylvania Railroad Company to take passengers to and from its terminus in the city of New York, for which the charges are separate from those of other transportation and wholly for service within the State of New York, is interstate commerce. The court held that it is not, although all persons using the cabs within the company's regulations are either going to or coming from the State of New Jersey by the company's ferry. "Many things have a more or less close relation to interstate commerce," said the court, "which are not properly to be regarded as a part of it. If the cab which carries the passengers from the hotel to the ferry landing is engaged in interstate transportation, why is not the porter who carries the traveler's trunk from his room to the carriage also so engaged? If the cab service is interstate transportation, are the drivers of the cabs and the dealers who supply hay and grain for the horses also engaged in interstate commerce? And where will the limit be placed?"

The Supreme Court of Minnesota last April, in the case of Connery vs. Quincy, Omaha & Kansas City (64 L. R. A., 624), held that a railroad car of a foreign company sent into that state with freight to be delivered there, and then, within a reasonable time necessary for its return, reloaded, and, in the customary and usual course of business, forwarded to the state from which it came is not liable to attachment issued in an action in the courts of Minnesota. It appeared that the car in question had been used in an interstate shipment of goods therein from St. Louis to points in Minnesota, North Dakota, and Montana, and at the time of the levy was empty and awaiting reloading by the Minnesota Transfer Company, in its yards, with a return shipment to points in Missouri. The court rested its decision on the commerce clause of the Federal Constitution and provisions of the act to regulate commerce.

Facilities of Traffic.—A recent exhaustive decision by the United States Supreme Court reversing the district court and court of appeals is to the effect that a water carrier holding itself out as a common carrier of perishable goods has the initial duty of providing and operating proper refrigerating apparatus for the safe carriage of such commodities. (Martin vs. Southwark, 191 U. S., 1.) This case applies the common law as modified by the Harter Act.

The Circuit Court of Appeals for the Eighth Circuit in the case of Harp vs. Choctaw, O. & G. (125 Fed. Rep., 445) affirmed the decision of the Circuit Court for the Western District of Arkansas, involving preference in furnishing cars, and held that a carrier which transports large quantities of coal is entitled to make regulations with respect to the manner of receiving and transporting it, so that it may be handled expeditiously, safely, and economically, without unnecessary interference with the carrier's other business; and that regulations which are well designed to promote such object cannot be complained of on the ground that they operate to give a preference to one who complies with them or as a discrimination against one who does not.

In the case of Robinson vs. B. & O. (129 Fed. Rep., 753), it appeared that a shipper refused to deliver coal to the carrier at a siding designated for that purpose, and, in his endeavor to compel the carrier to receive coal at another siding, intended for shippers of other merchandise, blocked such siding with teams for the purpose of obstructing traffic, and took possession of cars intended for other shippers, and dumped coal at the siding and station, which resulted in the total suspension of all freight business at the station for two days, and he threatened to continue such acts indefinately until the carrier submitted to his demands. The Circuit Court of Appeals for the fourth circuit held that such acts amounted to a public nuisance and justified relief by injunction.

The Circuit Court for the Northern District of Georgia, in Wilson vs. Atlantic Coast Line (129 Fed. Rep., 774), held that a rail-

*From the annual report of the Interstate Commerce Commission.

road company is not required, as a common carrier, to take a circus train, a part of which is loaded with wild animals, and transport the same over its line, but may refuse to transport such train, except under a special contract limiting its liability to that assumed by a private carrier.

State Railroad Commission Cases.—The question regarding liability of a reorganized railroad company under a state statute regulating passenger rates was determined by the United States Supreme Court in February last in the case of G. R. & I. vs. Osborn (193 U. S., 17). A peremptory writ of mandamus was granted by the Circuit Court of Kent County, Mich., commanding the defendant carrier to reduce its rates for passengers from 3 cents to 2½ cents per mile, as required by an act of the legislature of Michigan. The Supreme Court of Michigan affirmed the order of the Circuit Court, and the Supreme Court of the United States in its decision of affirmance held that the provisions in the railway law of Michigan of 1873, for the creation of a new corporation upon the reorganization of a railroad by the purchaser at a foreclosure sale, did not constitute a contract within the impairment clause of the Constitution of the United States. It also decided that purchasers of a railroad, not having any right to demand to be incorporated under the laws of a state, but voluntarily accepting the privilege and benefits of an incorporation law, are bound by the provisions of existing laws regulating rates of fare and are, as well as the corporation formed, estopped from repudiating the burdens attached by the statute to the privilege of becoming an incorporation.

The Supreme Court of the United States in M. & St. Louis vs. State of Minnesota (193 U. S., 53) held that to establish stations at proper places is the proper duty of a railroad company, and it is within the power of the states to make it prima facie a duty of the companies to establish them at all villages and boroughs on their respective lines; and that the law of Minnesota requiring the erection and maintenance of depots by railroad companies on the order of the Railroad and Warehouse Commission under the conditions stated in that law does not deny a railroad company the right to reasonably manage or control property or arbitrarily take its property without its consent or without compensation or due process of law and is not repugnant to the Constitution of the United States.

In Rosenbaum Grain Company vs. C., R. I. & Texas et al. (130 Fed. Rep., 46) the Circuit Court for the Northern District of Texas held that "a State railroad commission is without power to require a railroad company to cancel and abolish 'proportional tariffs' which apply only to interstate or foreign shipments, to prohibit the company from permitting export shipments of grain to be stopped in transit within the state for cleaning and grading, or by similar orders to attempt to regulate interstate or foreign commerce." The Circuit Court of Appeals for the Fifth Circuit affirmed the decision of the Circuit Court. (130 Fed. Rep., 110.)

The Supreme Court of Appeals of Virginia in A. C. L. et al. vs. Commonwealth (46 S. E. Rep., 911) decided that the rules prescribed by the corporation commission of the state with reference to storage, demurrage, car service and car-detention charges are not void because in their operation they affect incidentally interstate and foreign commerce.

Liability for Loss or Damage.—The Supreme Court of the United States decided last January in the case of Wabash vs. Pearce (192 U. S., 179) that where a contract of shipment from a point without to a point within the United States over the lines of several carriers provides that each carrier shall be liable only for loss or damage accruing on its own lines, the last carrier is not responsible for damages resulting from an examination by customs officers at a point not on its own line and different from the point to which the contract provided that the goods should be delivered in bond. The same court rendered another decision at its last term, involving limitations of common-law liability by contract. (Cau vs. Tex. & P., 194 U. S., 427.) The rulings of the court in this case were as follows: While primarily the responsibility of a common carrier is that expressed by the common law, and the shipper may insist upon such responsibility, he may consent to a limitation of it, and so long as there is no stipulation for an exemption which is not just and reasonable in the eye of the law the responsibility may be modified by contract. It is not necessary that an alternative contract be presented to the shipper for his choice. A bill of lading is a contract, and knowledge of its contents by the shipper will be presumed, and a provision therein against liability for damage by fire is not unjust or unreasonable. It is not necessary that there be an independent consideration apart from that expressed in the bill of lading to support a reasonable stipulation by exemption from liability. While the burden may be on the carrier to show that the damage resulted from the excepted cause, after that has been shown the burden is on the plaintiff to show that it occurred by the carrier's own negligence from which it could not be exempted.

The question as to when connecting carriers on through shipments are partners and jointly liable arose last February in the Circuit Court of Appeals for the Second Circuit, in the case of L. V. vs. Dupont (128 Fed. Rep., 840); and the court held that where the lines of several railroad corporations are conducted as a single system for the purpose of the traffic between different points, originating in either, and such corporations divided the proceeds of such business on a mileage basis, the several corporations as to such business were partners and liable to third parties on the principles of the law of agency. But it appeared that though the connecting carrier of the defendant in this case, upon whose line the accident occurred, operated and maintained the line financially and physically, yet the potential and ultimate control of all its property and business affairs was lodged in the defendant, and this control was exercised as completed and as directly as the machinery of corporate organisms would permit.

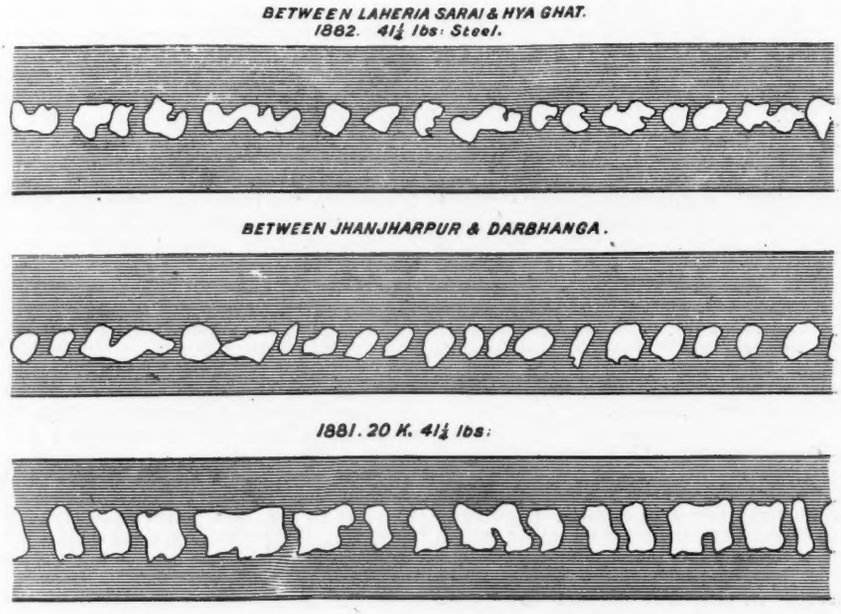
Land-Grant Railroads.—The act of Congress of July 2, 1864, which requires land-grant railroads to carry freight for the army at not exceeding 50 per cent. of the tariff rates charged the general public, was construed by the Circuit Court for the District of Oregon, in August last, in the case of United States vs. Astoria & C. R. (131 Fed. Rep., 1,006), wherein it was held that such law does not entitle the Government to a reduced rate for the carriage of freight between two points by a railroad company which received no land grant, merely because its trains run for a part of the distance over the track of a land-grant road.

Roaring Rails.

BY H. L. WILKINSON,
Resident Engineer, Bengal & Northwestern Railway Company.

Readers may be interested in a brief account of an investigation which I have recently conducted as to the cause of a mysterious complaint which attacks steel rails on many railroads out here, causing the rail surface to be worn, under the action of traffic, into a series of ridges and valleys or corrugations, perceptible to the eye and touch, which produce a deafening noise as the train passes over them. These peculiar rails seem to be mostly confined to the Tirhoot State Railways and Eastern Bengal State Railway, though they have also been found on other Indian lines. On the former line, of which I am in charge as resident engineer, there are about 150 miles of line, out of a total of 340, in which the rails have developed this "roaring" more or less badly. The number of "roarers" varies from 15 per cent. to 90 per cent. of rails in the track, the highest percentage being in a certain make of rails manufactured in the years 1880 to 1883. There are eight or ten other dates and makes, all of which exhibit various degrees of roaring. In fact, it is impossible to show that the defect is confined to any particular date or maker.

The illustration shows three samples of



Wheel Marks on Roaring Rails.

marks on the surface of roaring rails, and is reproduced from a tracing taken by myself by means of a piece of transparent paper and pencil. The uncolored, irregular-shaped figures represent the ridges of the surface of the rail. They appear to the eye as a row of bright polished patches, the rest of the rail surface being dull, showing that the wheel runs over these ridges, and does not touch the rest of the surface. Examination by the hand shows that the bright patches are really raised portions of the surface, with valleys in between. In some cases they stretch across nearly the whole width of the rail table, and appear as corrugations, but in the majority of cases they are as shown in the tracing, just raised lumps on the general surface. The height of these ridges, or, as some call it, the depth of the corrugations, has been measured, and found to average about 0.0035 in.

An important fact in connection with these rails, which has thrown considerable obscurity over the whole question, is that they are practically confined to a road ballasted with broken brick ballast. Also that they are worse on wooden sleepers than on steel or iron ones. Some engineers have hastily concluded from this that the cause lies in the use of brick ballast, quite forgetting that there are hundreds of miles of brick ballasted lines laid with steel rails and wooden sleepers, where roaring is unknown. It has been proved, however, that roaring rails wear absolutely smooth when taken out of a brick ballasted road and laid in a road boxed with earth, or even when left alone in the track, and all the top brick ballast removed and replaced by earth boxed up to rail level, without touching the brick ballast under the sleepers.

These experiments are certainly interesting, but they are liable to throw one on a false scent, as it is hopeless to look for the cause of the defect in any quality of the ballast; and, personally, I am convinced it has to do with some condition or quality in the steel of the rails.

It has also been found that the steel of the "ridges," or raised portions of the rail surface, cannot be scratched with a penknife or file, whereas the metal in between can be scratched easily. It has been concluded from this that the rail is laminated transversely with hard and soft metal alternately.

To settle this matter I took up some roaring rails, and tested them for hardness by the method indicated in Professor J. B. Johnson's "The Materials of Construction," pages 381 to 383, a method which has been recommended for use by the Government of India for testing the hardness of steel. It consists in dropping a given weight from a given height on to a steel punch of a certain peculiar wedge shape, and noting the length of the indentation produced in millimeters, from which, by applying a formula including the weight of the falling body in kilogrammes and the height of fall in millimeters, the degree of hardness can be calculated in kilogramme-millimeter units. Adopting this method, I found that there was practically no difference in hardness between the steel of the ridges and valleys respectively, so that the penknife and file test was illusive, and merely indicated a difference of hardness of the outer skin, caused by the wheels of the vehicles bearing on the ridges only.

I, however, made an important discovery when testing non-roaring or normal rails, and comparing the tests with those of roaring rails. I found that the roaring rails were in every case quite abnormally hard, some four or five times as hard as the non-roarers. And this was specially noticeable in comparing a roaring rail and a non-roaring rail taken from the same portion of the track and belonging to the same make and date. For instance, a roaring rail and a smooth rail, both of the same make and date, and laid near each other in the same track, were tested for hardness, and gave the following results:

	K.m., units.
Roaring rail:	
Average of 12 tests on head	1,483
Average of 6 tests on web	830
Smooth rail:	
Average of 12 tests on head	1,142
Average of 6 tests on web	460

Another roaring rail, which I sliced longitudinally down the middle and tested on the exposed surface, showed enormously high average hardness, varying from 1,142 units down in the web to 3,854 units in the head. The degree of hardness given for medium steel—for cannons—hardened in oil, in a list printed in Professor Johnson's book above mentioned, is 455 kilo-millimeter units, which is little different from the tests shown by the webs of normal, smooth rails.

This shows the enormous relative hardness of the steel of the roaring rails. When with this is taken the fact, generally admitted, that not a single case of "roaring" has ever been found among iron rails, it seems pretty plain that, whatever the theory of the peculiar row of raised patches may be, the phenomenon is due to or dependent on excessive hardness of the steel of the rail, combined with the effect of passage of the rolling stock. Probably the hard rail is thrown into more intense and rapid vibration than the soft rail, the effect being enhanced by a resonant track, and the row of symmetrically disposed and similar shaped ridges on the surface is in some way an effect of this vibration. The question is, granting that the mischief is really due to hardness, how are rails of this abnormal hardness produced?

As regards chemical composition, these roaring rails have been sent home and analyzed, and it is stated that their chemical composition is quite normal. Recently, two roaring rails and one normal rail from the Eastern Bengal State Railway were sent to Cooper's Hill Laboratory and analyzed, and the results published by the analyst are as follows:

	Rails		
	Roaring		Normal.
Carbon	0.691	0.472	0.459
Silicon	0.148	0.052	0.569
Sulphur	0.067	0.124	0.076
Phosphorus	0.078	0.100	0.058
Manganese	2.090	1.050	0.950

The analyst at Cooper's Hill concluded from these figures that there was nothing abnormal in the composition of the roaring rails except, possibly, an excess of manganese.

I understand that roaring rails are not unknown in England, but are removed from the track as soon as discovered, and that it is believed that they are manufactured from one particular ore, the "East Coast hematite," which produces an excessively hard rail, the hardness being the result of a slight excess of sulphur and phosphorus. If so, it not only bears out my own conclusions, but is also supported to a certain extent by the Cooper's Hill analysis, which shows an excess of phosphorus in the roaring rails.

To conclude, my inquiry into this problem has led me to attribute the production of roaring rails to one original cause only—excessive hardness of the steel. This sets up intense and undue vibration in the rail under the action of traffic, which is enhanced when the track has resonant properties. The nature of this vibration is that a row of "nodes," or "nodal surfaces," is produced along the table of the rail, on which the wheel runs, while the rest of the rail surface is untouched by the wheel, and consequently rusts away. These "nodes" become eventually a row of ridges of steel raised above the general level, the rail being so hard that there is no perceptible wear on the ridges.

This may not be the true or the whole explanation; but, be this as it may, one thing is certain—that "roaring" rails are very much harder than ordinary rails. I have proved this by a large number of experiments, many within the last few weeks, and they have confirmed this conclusion without a single exception.

It is reasonable, therefore, to look upon this excessive hardness as the chief cause of the defect. This narrows the inquiry, since it only remains to consider what it is that causes the hardness. I feel convinced that it will be found to be an excess of one or two of the elements of phosphorus, sulphur, or manganese in the steel.—*The Engineer, London.*

Telephones on the B. & O.

The Baltimore & Ohio after a conference of operating officers has authorized its superintendents to use telephones for moving trains wherever desirable and economical. A set of rules and forms has been adopted so as to reduce the method of handling trains by telephone to a standardized system, and it is the intention to equip every non-telegraph station that has a passing siding with a telephone connection to the nearest telegraph office. This will enable the transmission of train orders direct from the telegraph office to the train crews at such sidings, or to an employee stationed there for that purpose.

The Baltimore & Ohio already has the telephone in use at many places for the transmission of ordinary business messages, division headquarters being connected with the terminals of the divisions by means of the "composite" arrangement for simultaneous working of the telephone and the telegraph on the same wire. Such circuits have been established between Chicago and Garrett, Ind.; between Garrett and Chicago Junction, Ohio, thus covering the Chicago division; between Newark and Chicago Junction; between Newark and Wheeling; between Wheeling and Fairmont; between Grafton and Wheeling; between Pittsburg and Wheeling, and between Wheeling and Holloway, thus connecting the General Superintendent of this Grand Division with the various superintendents and terminals with which he deals. Other circuits have been established from Grafton to Clarksburg; Clarksburg to Parkersburg, and from Grafton to Cumberland, thus completing the circuits for the divisions centering at Grafton. There are also circuits between Baltimore and Brunswick, Md., and from Baltimore to Philadelphia for a like purpose.

In addition to these long circuits the telephone is used extensively in single track blocking and for the movement of yard engines; and for the connection of non-telegraph stations with telegraph stations so that trains are moved from the former to the latter to receive ordinary telegraph train orders. The telephone is used for single track blocking in this manner between Newark and Bellaire, Ohio. The telegraph offices average about eight miles apart. At many points the siding extends beyond the telegraph office about two miles. By having a telephone at the outlying switches, a train is allowed to use the passing siding up to the outlet switch, and in this way the blocks are practically shortened, so far as main-track use is concerned, just as much as the side tracks extend into the blocks. In some instances this arrangement permits the use of four miles of passing tracks, leaving four miles as the net length of the section to be blocked. This method of using the telephone between Newark and Bellaire, over 104 miles of single track, has been in use for about two and a half years with marked success.

Autobiography of H. H. Vreeland.

Railroad Men prints the following history of Mr. Vreeland's early days, as recounted by himself:

The first work I ever did was not upon a railroad. When I was a lad of 13 I worked with a gang of men at filling the city ice carts and though it was hard labor, I was glad of the opportunity to earn some money. I also drove a grocery wagon for a time. My ambition, however, was to work upon a railroad, and I was constantly on the lookout for an opening. When I was 18 I got a job at shoveling gravel on the cars of the Long Island Railroad night construction trains. I felt that this was a great opportunity. I had been wanting to be a railroad man, and now that I was on a gravel train I determined to stay there until I got something better.

After a few months I was given a job at inspecting the ties and roadbed, at a dollar a day. I then felt that I was well upon the way to the presidency of the corporation. My next position was that of switchman, and I felt that this was a very great promotion. It gave me an opportunity to learn more about the railroad business. The Bushwick station was near by, and I made the acquaintance of the officials there. I offered to help them with their clerical work whenever I was off duty, and that was exactly what they wanted. It was what I wanted, too, for I was desirous of learning the business from the bottom up. Many a time I worked until 11 or 12 o'clock at night in that little station, figuring out train receipts and expenses, engine cost and duty, and freight and passenger statistics of all kinds; and as a result of this work I quickly acquired a grasp of railroad details which few managers possess, for in one way and another I acquired a knowledge of every branch of the business.

My position as switchman was only a temporary one, connected with the construction work which was going on, and when the work was completed I was discharged. I wasn't surprised at this, for I knew the conditions, and had expected that I wouldn't be needed there for long. I was determined, however, to stay on the road if I could. I went to one of the officials and told him that I wanted to remain with the Long Island Railroad Company in any capacity whatsoever, and would be obliged to him if he would give me work. He said at first that he had nothing for me to do; but finally added that if I had a mind to go down on another division and sweep out and dust cars, I might do it. I instantly accepted, and in this new place I learned the details of another important department of railroad work. It never occurred to me that dusting cars wasn't the highest class of service. I was with the railroad and was satisfied.

After a while I was made brakeman on an early mail train running to Hempstead, and then I found that I was worth to the world, after two years of railroad training, just 40 dollars a month. I paid out 18 dollars for my board and lodging, and sent 20 dollars home for the support of my mother and sister.

The men on the road used to chat a good deal about what they expected to become, and I used to say that I intended to be the president of the road. Of course the fellows all laughed at that. They said that I might get to be conductor, but above that I could never hope to rise. They nicknamed me "President Vreeland," and we used to have many jokes about what the future had in store for us.

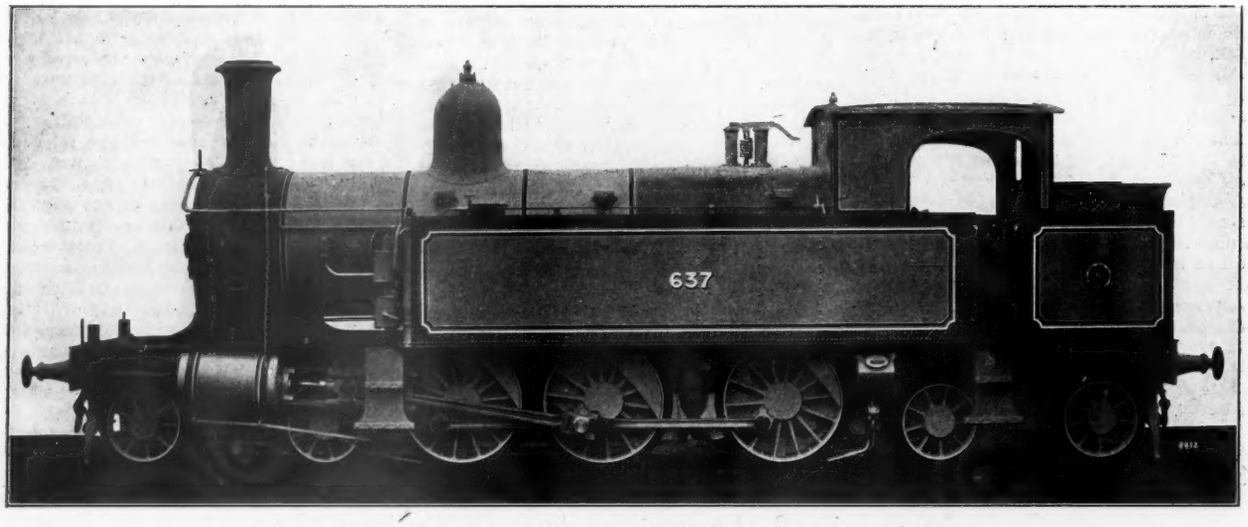
I was made a conductor before very long, and thought I was surely on the high road to success when there was an accident for which I and the engineer were held jointly responsible. We admitted that we had made a mistake, and were immediately discharged. I went again to the superintendent, and upon a strong plea to be retained in the service, he sent me back to the ranks of the brakemen. Of course I had to accept the consequences of my mistake, and it was no use to make a complaint. The fact that I had blundered, however, didn't change the fact that I had a fund of valuable experience, and I was able to impress upon my superiors my willingness to start again at the bottom and work up.

When the road changed hands, after a time, I was successful in assisting the General Manager in his work. He was a man who knew little about the practical details of railroading, and he was glad to have me help him. When any man attracts the favorable notice of his superiors, he may feel reasonably sure of promotion, and once I had proved that I possessed experience my advancement was rapid. The years I had spent in mastering details bore fruit all at once.

It has always been my experience that the first thing for a railroad man to do is to learn thoroughly the work in which he is engaged. When he has learned to be a good brakeman, he should look into the duties of the conductor, and while he is serving as fireman, he should fit himself to become an engineer when the opportunity arrives. The man who is really determined to succeed, and is willing to work, will usually get there. No artificial condition can ever, in my judgment, keep down a man who has health, capacity and honesty. You can temporarily interfere with him or make the road to the object of his ambition more difficult, but you cannot stop him. That tyranny is forever dead, and since its death there has come a great enlightenment to the possessors of power and wealth. Instead of preventing a man from rising, there is not a concern the wide world over that is not to-day eagerly seeking for capable people. The great hunger of the time in the railroad business as in every other is for good men, strong men, men capable of assuming responsibility; and there is sharp competition for those who are available.

New South Wales Suburban Tank Locomotives.

In our issue of October 7, in reviewing the annual report of the New South Wales Railways for last year, mention was made of the large additions made to the motive power of the lines which included 24 freight, one passenger and 35 suburban tank locomotives. The tank locomotives were built by Beyer, Peacock & Co., Lim., of the Gorton Foundry, Manchester, England. They are built to standard gage, 4 ft. 8½ in., and have a somewhat unusual arrangement of wheels, being of the 4-6-4 type. The cylinders are outside of the frames and are inclined downward. The two side tanks have a capacity of 1,580 Imp. gallons of water and 2½ tons of coal can be carried in the bunker back of the cab. The following are the principal dimensions:



4-6-4 Suburban Tank Locomotive, New South Wales Government Railways.

Total weight in working order, lbs.	161,432
Weight on drivers, lbs.	95,900
Weight on leading truck, lbs.	29,888
Weight on trailing truck, lbs.	35,644
Total wheel base, ft. and in.	32—8
Rigid wheel base, ft. and in.	10—9
Diameter of driving wheels, in.	55
Diameter of truck wheels, in.	37
Cylinders, diameter, in.	18½
Cylinders, stroke, in.	24
Boiler—type	Belpaire
Diameter, in.	52¼
Length of barrel, ft. and in.	12—1½
Fire-box, material	Copper
Length, in.	82⅝
Width, in.	41¾
Tubes, number	219
Length, ft. and in.	12—4⅝
Diameter, in.	1⅞
Heating surface, tubes, sq. ft.	1,334.1
Heating surface, fire-box, sq. ft.	118.6
Heating surface, total, sq. ft.	1,452.7
Grate area, sq. ft.	24
Working steam pressure, lbs.	160